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THE RADIAL VELOCITIES OF LONG-PERIOD VARIABLE STARS SECOND PAPER*

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ABSTRACT

Measurements of radial velocity.—These were taken from 618 Mount Wilson spectrograms of 206 long-period variables of spectral classes Me and Se and are recorded in Table 1. For 152 of these objects no previous measurements have been reported. The velocities of 305 variables in Table 3 summarize all known measurements. It is recommended that velocities derived from the absorption lines (which differ appreciably from those derived from the emission lines) be used in studies of galactic motions. For 72 stars of Table 3, direct measurements of the absorption lines are available; for the other stars the measured emission-line displacements were corrected in the manner described in *Mt. W. Contr.*, No. 644. A brief statistical study is given of the types, periods, and galactic latitudes of the stars in Table 3.

Discussion of galactic motions.—The residual radial velocities computed by applying the corrections for ordinary solar motion are decidedly high, the arithmetic mean being 36 km/sec. The higher velocities are associated with the earlier spectral types and the shorter periods (Tables 6 and 7 and Figs. 3 and 4). The relationship with period is particularly well marked. Among 152 stars with periods shorter than 300 days, 16 have residual velocities greater than 100 km/sec, 10 have velocities between 80 and 100 km/sec; while among 153 stars with periods of 300 days or longer not one has a velocity exceeding 100 km/sec, and only 2 have velocities between 80 and 100 km/sec. The average velocity decreases steadily from 80 km/sec for a group of 27 stars with periods from 150 to 199 days to 17 km/sec for 35 stars with periods greater than 399 days. The evolutionary significance of these results is important but obscure.

After correction for solar motion, the 305 variables have a group motion, V_0, of 31 km/sec toward the apex $\alpha = 316°$, $\delta = +50°$ (see Table 8). When the stars are divided according to the absolute values of the residual velocity, V_0 is only 4 km/sec for the group with velocities less than 25 km/sec, while for the remaining stars V_0 is 60 km/sec. A somewhat similar result is obtained when the stars are divided according to period of light-variation. On the other hand, when the stars are divided according to distance from the sun, V_0 is nearly the same for both groups. The well-marked relationship of group motion to random stellar velocity (Fig. 5) is an excellent example of the asymmetry of high stellar velocities. The apex for the high-speed stars is near that point of the sky toward which stars near the sun are moving in their huge galactic orbits. This fact confirms the view that the velocity asymmetry is an effect exhibited by stars having unusually small circular velocities in their galactic orbits. The radial components may be exceptionally large.

Since the publication in 1923 of a discussion[1] of the radial velocities of 133 long-period variables of spectral classes Me and Se, Miss Leah B. Allen's measurements[2] of the velocities of 20 southern variables have appeared, and numerous additional data on northern variables have been obtained at Mount Wilson. Altogether, radial velocities are now available for 305 variables, 281 of class Me, 24 of class Se.

MOUNT WILSON OBSERVATIONS

In my program at Mount Wilson the intention has been to include only those long-period variables with normal light-curves and standard Me or Se spectra. Stars with unknown periods, irregular light-curves, or exceptionally small magnitude ranges have been omitted. The selection of suitable objects was greatly facilitated in 1936 by the opportunity of examining the light-curves of a large number of variables plotted at the Harvard Observatory under the direction of Mr. Leon Campbell. My colleague, Mr. A. H. Joy, has had the kindness to call to my attention several stars found in the course

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[1] P. W. Merrill, *Mt. W. Contr.*, No. 264; *Ap. J.*, **58**, 215, 1923.

[2] *Lick Obs. Bull.*, **12**, 71, 1925.

of his study of nonemission M-type variables to have typical Me spectra and to give me one or more spectrograms of each. In partial return I have handed him a few plates of variables on my program in whose spectra the bright hydrogen lines proved to be absent or unduly weak.

The observational methods did not differ greatly from those described in *Mount Wilson Contributions*, No. 264,[1] except that for the fainter stars a 10-inch camera, dispersion 65 A/mm at $H\gamma$, was generally employed instead of an 18-inch camera, dispersion 35 A/mm. Since March, 1937, the Cramer Hi-Speed Special emulsion has been regularly used; previously either Eastman 40 or Imperial Eclipse 850 had been used.

Description of Table 1.—Measurements not previously published are in Table 1. The dates given are for the calendar day preceding the night of observation. An asterisk indicates that the plate was taken with the 18-inch camera instead of the 10-inch; this differs from the use of the asterisk in *Mt. W. Contr.* No. 264, Table III. The phase is reckoned in days before (−) or after (+) the nearest maximum. I am indebted to Director Harlow Shapley and Mr. Leon Campbell of the Harvard Observatory for supplying much unpublished photometric material. All the spectrograms have been measured twice; with few exceptions one measure was by Miss Cora G. Burwell, while the second was either by Miss Burwell after an interval of several months or by the writer. Details concerning the absorption and emission lines regularly used will be found in *Mt. W. Contr.*, No. 644.[3] The individual emission lines used for velocity are in general much the same as those indicated in *Mt. W. Contr.*, No. 264, Table III; hence it has seemed sufficient to record for each plate only the number of lines upon which the velocity depends. The lines most frequently measured were, as before, $H\gamma$ and $H\delta$.

[3] *Ap. J.*, **93**, 380, 1941.

TABLE 1

RADIAL-VELOCITY OBSERVATIONS OF LONG-PERIOD VARIABLES AT MOUNT WILSON

Star	Date	JD 242	Mag.	Phase (Days)	Velocity (km/sec) Emission	No. Lines	Absorption	No. Lines
SS Cas 000451.....	1935 Sept. 18	8064	10.2	−14	−24	2	....	......
	19	8065	10.2	−13	−26	2	....	......
	20	8066	10.1	−12	−27	2	....	......
					−25.4			
X And 001046.....	1922 Oct. 8*	3336	9.4	−24	−29	1	....	......
	1923 Sept. 30*	3693	9.7	−23	−16	1	....	......
	Oct. 3*	3696	9.7	−20	−18	2	....	......
	26	3719	9.5	+3	−17	2	....	......
	Nov. 28	3752	10.2	+36	−16	1	....	......
	1924 Sept. 15	4044	8.9	+4	−18	2	....	......
					−18.5			
T Cas 001755.....	1923 Oct. 1*	3694	7.8	+28	−28	3	(−20)	24
	1928 Aug. 30*	5489	7.7	+21	−21	3	(−10)	28
					−24.5		(−14.8)	
R And 001838.....	1921 Dec. 15*	3039	7.5	−16	−29	3	(−14)	14
	1925 July 7*	4339	9.0	+38	−23	3	....	......
	Sept. 3	4397	10.5	+96	−27	5	....	......
	1927 Sept. 9*	5133	7.8	+12	−36	2	....	......
	1928 Oct. 5*	5525	6.7	+6	−25	5	−4	54
	1939 Jan. 13*	9277	8.0	+40	−23	7	....	......
					−26.9		(−7.3)	
Y Cep 003179.....	1927 Sept. 16*	5140	10.4	−9	−16	2	....	......
	17*	5141	10.4	−8	−15	2	....	......
	1939 July 29	9474	9.6	−17	−7	2	....	......
					−12.5			
U Cas 004047.....	1923 July 27	3628	11.5	+67	−58	2	....	......
	1924 Nov. 10	4100	7.4	−11	−48	4	....	......
	Dec. 13	4133	8.1	+22	−61	4	....	......
	1925 Jan. 6	4157	9.2	+46	−54	6	....	......
	Sept. 2	4396	8.9	−6	−55	3	....	......
	30	4424	9.0	+22	−52	3	....	......
					−54.2			
RW And 004132.....	1929 Sept. 12	5867	8.2	−13	−22	3	....	......
	13*	5868	8.2	−12	−35	3	....	......
	1930 Dec. 5	6316	9.0	+6	−26	3	....	......
					−29.6			

* Dispersion about 35 A/mm at $H\gamma$.

TABLE 1—*Continued*

Star	Date	JD 242	Mag.	Phase (Days)	Velocity (km/sec) Emission	No. Lines	Absorption	No. Lines
RR And 004533.....	1935 Aug. 12	8027	9.6	+27	−85	3	....	......
	15	8030	9.7	+30	−84	3	....	......
					−84.6			
RV Cas 004746a....	1926 Aug. 10	4738	9.5	+7	−80	1	....	......
	1935 July 19*	8003	8.7	−23	−81	1	....	......
					−80.4			
W Cas 004958.....	1926 July 26*	4723	8.2	−18	−57	2	....	......
	Aug. 10	4738	8.0	−3	−59	2	....	......
					−57.6			
Z Cet 010102.....	1935 Aug. 16	8031	11.6	+52	−9	2	....	......
	1940 Jan. 21	9650	9.0	+10	−4	4	....	......
					−6.2			
X Psc 010621.....	1934 Nov. 21	7763	(10.1)	....	−3	2	....	......
	1935 Nov. 9	8116	(8.3)	....	−3	2	....	......
					−3.1			
U And 010940.....	1935 Oct. 7*	8083	10.4	−18	−22	2	....	......
	Nov. 10	8117	10.2	+16	−13	3	....	......
					−18.7			
UZ And 011041.....	1937 Oct. 24	8831	10.0	−11	−49	2	....	......
	25	8832	10.0	−10	−48	2	....	......
	25	8832	10.0	−10	−57	2	....	......
					−51.2			
S Cas 011272.....	1923 July 29*	3630	7.7	−1	−51	3	....	......
	Sept. 2*	3665	8.4	+34	−53	3	....	......
					−51.8			
RZ Per 012350.....	1935 Oct. 7*	8083	9.5	−24	−25	2	....	......
	Nov. 10	8117	9.7	+10	−27	2	....	......
					−25.9			
SX And 012746.....	1937 Feb. 1	8566	(10.1)	....	−81	2	....	......
	1939 Jan. 11	9275	(10.2)	....	−84	2	....	......
					−82.3			

TABLE 1—*Continued*

Star	Date			JD 242	Mag.	Phase (Days)	Velocity (km/sec) Emission	No. Lines	Absorption	No. Lines
U Per 015254.....	1939	Dec.	3*	9601	8.0	+ 11	+ 11	9	+ 18	69
			22*	9620	8.0	+ 30	+ 2	3	....	......
							+ 6.7			
S Ari 015912.....	1937	Sept.	23	8800	10.0	− 13	− 40	2	....	......
			24	8801	10.0	− 12	− 37	2	....	......
			24	8801	10.0	− 12	− 34	2	....	......
							− 36.9			
RR Per 022150.....	1929	Sept.	12	5867	9.5	+ 23	− 2	2	....	......
			14*	5869	9.6	+ 25	− 7	2	....	......
							− 5.4			
U Ari 030514.....	1935	Aug.	12	8027	8.8	+ 24	− 53	3	....	......
			15	8030	8.9	+ 27	− 50	5	....	......
							− 51.3			
X Cet 031401.....	1929	Nov.	22	5938	8.7	− 3	+ 54	2	....	......
		Dec.	14*	5960	9.0	+ 19	+ 48	2	....	......
							+ 50.8			
U Eri 034625.....	1937	Oct.	24	8831	10.2	− 20	− 42	2	....	......
			25	8832	10.2	− 19	− 44	2	....	......
							− 43.1			
S Tau 042309.....	1937	Oct.	24	8831	11.4	− 5	+ 22	2	....	......
			26	8833	11.4	− 3	+ 30	2	....	......
	1938	Oct.	10	9182	10.6	− 16	+ 33	3	....	......
			11	9183	10.6	− 15	+ 20	2	....	......
							+ 26.3			
RX Tau 043208.....	1938	Nov.	7	9210	10.7	+ 14	− 36	4	....	......
			7	9210	10.7	+ 14	− 36	6	....	......
	1939	Oct.	3	9540	10.0	+ 11	− 38	5	....	......
							− 36.4			
V Tau 044617.....	1928	Jan.	5*	5251	10.7	− 13	+ 70	2	....	......
	1929	Nov.	22	5938	9.4	− 3	+ 75	2	....	......
		Dec.	14*	5960	9.5	+ 19	+ 58	3	....	......
	1940	Mar.	29	9718	10.7	+ 36	+ 53	2	....	......
							+ 64.1			

TABLE 1—*Continued*

Star	Date	JD 242	Mag.	Phase (Days)	Velocity (km/sec) Emission	No. Lines	Absorption	No. Lines
R Ori								
045307.....	1923 Aug. 29	3661	9.3	+ 11	+ 19	1	....	......
	Sept. 1*	3664	9.3	+ 14	+ 20	2	....	......
	1924 Sept. 15	4044	10.0	− 10	+ 17	3	....	......
					+ 18.9			
R Aur								
050953.....	1926 Sept. 16*	4775	9.0	+ 3	− 9	1	....	......
	1927 Dec. 23*	5238	8.6	− 26	− 8	2	+ 10	35
	1928 Jan. 4*	5250	8.3	− 14	− 10	2	....	......
	1930 Sept. 11*	6231	8.7	+ 31	− 13	2	....	......
	1935 Sept. 18*	8064	8.4	+ 30	− 9	8	+ 8	48
	19*	8065	8.4	+ 31	− 6	6	+ 10	31
	20*	8066	8.5	+ 32	− 9	6	+ 6	32
	20*	8066	8.5	+ 32	− 8	4	(+ 6)	17
					− 9.1		+ 7.8	
AC Aur								
051950.....	1935 Aug. 16	8031	(10.2)	....	− 33	2	....	......
	1940 Oct. 19*	9922	(10.2)	....	− 33	3	....	......
	20*	9923	(10.2)	....	− 32	2	....	......
					− 32.6			
W Aur								
052036.....	1937 Mar. 28	8621	10.6	− 21	−139	2	....	......
	29	8622	10.6	− 20	−140	2	....	......
					−139.6			
S Ori								
052404	1934 Nov. 21	7763	7.0	− 3	+ 10	2	....	......
	1936 Mar. 5	8233	9.3	+ 47	+ 7	2	....	......
					+ 8.3			
RU Aur								
053337.....	1937 Feb. 2	8567	10.1	+ 28	− 56	2	....	......
	27	8592	11.3	+ 53	− 48	4	....	......
					− 52.0			
U Aur								
053531.....	1927 Dec. 22*	5237	8.6	+ 7	+ 6	2	+ 12	37
	1928 Jan. 5*	5251	9.2	+ 21	+ 8	2	+ 22	21
	Feb. 11*	5288	10.9	+ 58	+ 7	3	....	......
					+ 7.1		+ 15.3	
S Col								
054331.....	1938 Oct. 10	9182	9.7	+ 20	+ 61	2	....	......
	11	9183	9.7	+ 21	+ 59	2	....	......
					+ 59.7			

TABLE 1—*Continued*

Star	Date	JD 242	Mag.	Phase (Days)	Velocity (km/sec) Emission	No. Lines	Absorption	No. Lines
R Col 054629	1936 Mar. 7	8235	9.7	− 8	(+ 58)	2	....	.....
	1937 Mar. 1	8594	9.0	+ 15	+ 54	2	....	.....
	2	8595	9.1	+ 16	+ 60	2	....	.....
					+ 57.4			
U Ori 054920a	1923 Oct. 1*	3694	7.4	+ 44	− 34	3	− 18	33
	28*	3721	8.1	+ 71	− 34	2	− 17	26
	1926 Sept. 17*	4776	5.9	+ 2	− 37	2	− 24	26
	20*	4779	5.9	+ 5	− 37	2	− 22	24
	Oct. 22*	4811	6.6	+ 37	− 39	3	− 22	22
	1927 Oct. 13*	5167	6.8	+ 21	− 30	2	− 25	50
	14*	5168	6.9	+ 22	− 32	2	− 21	22
	Nov. 10*	5195	7.8	+ 49	− 32	2	− 24	37
	1939 Dec. 21*	9619	6.6	− 11	− 35	2	....	.....
	23*	9621	6.5	− 9	− 31	4	− 20	64
	28*	9626	6.5	− 4	− 35	4	− 23	100
	1940 Jan. 20*	9649	6.7	+ 19	− 32	4	− 21	91
	28*	9657	6.8	+ 27	− 35	8	− 22	64
	Feb. 20*	9680	7.4	+ 50	− 31	2	....	.....
					− 33.8		− 21.6	
RS Aur 055646a	1940 Oct. 29	9932	9.6	− 8	+ 14	2	....	.....
	Nov. 19	9953	9.8	+ 13	+ 5	2	....	.....
	1941 Jan. 11	0006	10.6	+ 66	+ 7	2	....	.....
					+ 8.7			
RR Aur 060443	1936 Mar. 5	8233	(10.2)	....	+ 14	2	....	.....
	7*	8235	(10.2)	....	+ 13	3	....	.....
					+ 13.7			
U Lyn 063159	1937 Feb. 2	8567	11.0	− 8	− 32	1	....	.....
	Mar. 1	8594	11.1	+ 19	− 30	1	....	.....
	2	8595	11.1	+ 20	− 28	1	....	.....
					− 29.8			
S Lyn 063558	1929 Feb. 27	5670	10.5	0	− 16	2	....	.....
	28	5671	10.5	+ 1	− 28	2	....	.....
					− 21.7			
Y Mon 065111	1925 Dec. 26*	4511	9.4	+ 25	+ 59	2	....	.....
	1927 Mar. 16	4956	9.1	+ 11	+ 65	2	....	.....
					+ 60.9			

TABLE 1—*Continued*

Star	Date	JD 242	Mag.	Phase (Days)	Velocity (km/sec) Emission	No. Lines	Absorption	No. Lines
X Mon 065208.....	1939 Dec. 3*	9601	9.6	− 72	+164	2	....	......
	1940 Feb. 27*	9687	7.5	+ 14	+152	5	+164	13
	Mar. 16*	9705	8.1	+ 32	+153	2	....	......
					+156.4			
R Lyn 065355.....	1925 Sept. 30	4424	9.9	+ 62	+ 10	3	....	......
	1935 Nov. 10	8117	(8.6)	− 30	+ 10	3	....	......
	1937 Feb. 27	8592	9.9	+ 70	+ 4	4	....	......
	1939 Jan. 13*	9277	8.0	0	+ 12	4	....	......
					+ 9.9			
R Gem 070122a....	1937 Mar. 28	8621	8.6	+ 52	− 49	2	....	......
	1938 Feb. 16†	8946	7.5	+ 52	(− 59)	2	− 42	44
	19*	8949	7.5	+ 55	− 55	1	(− 46)	21
	1939 Jan. 10*	9274	7.4	− 26	− 58	1	....	......
	13*	9277	7.3	− 23	− 61	3	(− 36)	19
	1940 Jan. 20*	9649	7.6	− 21	− 50	2	− 44	28
					− 55.3		− 42.0	
V CMi 070109.....	1935 Oct. 7*	8083	9.6	− 28	+ 22	1	....	......
	Nov. 10	8117	9.7	+ 6	+ 21	2	....	......
	1937 Oct. 24	8831	8.9	− 18	+ 27	2	....	......
					+ 23.2			
R CMi 070310.....	1923 Jan. 7*	3427	8.1	− 12	+ 28	1	....	......
	1925 Oct. 30	4454	7.6	− 4	+ 31	2	....	......
	Dec. 24*	4509	8.2	+ 51	+ 41	2	....	......
					+ 33.3			
RR Mon 071201.....	1927 Jan. 18	4899	9.4	+ 7	+ 13	2	....	......
	1938 Nov. 7	9210	10.0	− 26	+ 17	2	....	......
					+ 13.8			
Z Pup 072820b....	1928 Jan. 6*	5252	7.3	− 12	+ 9	2	....	......
	Mar. 16*	5322	8.6	+ 58	+ 7	2	....	......
	1930 Dec. 4*	6315	8.5	+ 12	+ 12	2	....	......
	1937 Oct. 26	8833	8.2	+ 21	+ 27	2	....	......
					+ 11.7			
T CMi 072811.....	1939 Apr. 4	9358	11.3	+123	+ 18	2	....	......
	6	9360	11.3	+125	+ 27	2	....	......
					+ 22.7			

† Dispersion about 20 A/mm.

TABLE 1—*Continued*

Star	Date	JD 242	Mag.	Phase (Days)	Velocity (km/sec) Emission	No. Lines	Absorption	No. Lines
U CMi 073508	1937 April 29	8653	9.7	− 28	+ 44	2	....	......
	30	8654	9.7	− 27	+ 39	2	....	......
					+ 42.0			
S Gem 073723	1934 Oct. 25*	7736	10.4	− 34	+101	2	(+104)	26
	Nov. 21	7763	9.2	− 7	+101	3	....	......
					+101.3			
W Pup 074241	1937 Mar. 1	8594	9.1	+ 13	(+ 18)	1	....	......
	Oct. 26	8833	9.4	+ 17	(+ 9)	1	....	......
					+ 15.0			
T Gem 074323	1923 Oct. 27	3720	9.9	+ 60	+ 12	2	....	......
	1925 Mar. 3	4213	9.4	− 47	+ 15	1	....	......
	Apr. 9	4250	8.9	− 10	+ 6	3	....	......
	May 5	4276	8.9	+ 16	+ 10	3	....	......
	Dec. 25*	4510	9.0	− 40	+ 18	3	....	......
	1926 Jan. 25	4541	8.7	− 9	(+ 19)	4	....	......
	28*	4544	8.7	− 6	+ 11	3	....	......
	Feb. 18*	4565	8.9	+ 15	+ 8	3	....	......
					+ 11.3			
U Pup 075612	1934 Oct. 25*	7736	(9.2)	+ 5	− 12	2	....	......
	1940 Nov. 19	9953	9.7	+ 11	− 15	2	....	......
					− 13.4			
R Cnc 081112	1939 May 6*	9390	8.4	− 23	+ 19	2	+ 29	24
V Cnc 081617	1924 Apr. 16	3892	8.0	+ 15	− 12	2	....	......
	1925 Jan. 6*	4157	8.1	− 14	(+ 1)	2	....	......
	1940 Jan. 21*	9650	8.8	+ 37	− 5	2	....	......
					− 6.4			
X UMa 083350	1936 Apr. 5	8264	10.6	+ 12	− 86	2	....	......
	7*	8266	10.7	+ 14	− 94	2	....	......
					− 91.3			
S Hya 084803	1940 Jan. 29*	9658	7.7	+ 2	+ 68	2	....	......
S Pyx 090024	1925 Mar. 4*	4214	12.4	+ 31	+ 80	2	....	......
	1927 Dec. 22*	5237	(8.3)	....	+ 90	3	....	......
	1928 Dec. 21*	5602	(7.9)	....	+ 99	3	....	......
	1940 Apr. 17	9737	9.2	− 13	+ 90	2	....	......
					+ 89.9			

TABLE 1—*Continued*

Star	Date	JD 242	Mag.	Phase (Days)	Velocity (km/sec) Emission	No. Lines	Absorption	No. Lines
X Hya								
093014.....	1931 Dec. 1	6677	8.6	+ 27	+ 25	2	....	......
	1935 Mar. 25*	7887	8.6	+ 4	+ 30	3	+ 42	21
					+ 28.6			
Y Dra								
093178.....	1925 Apr. 7*	4248	10.4	− 51	(+ 17)	1	....	......
	May 6*	4277	9.1	− 22	+ 10	2	....	......
	7*	4278	9.0	− 21	+ 9	2	....	......
					+ 10.3			
RR Hya								
094023.....	1931 May 8	6470	9.7	− 20	(+ 27)	2	....	......
	1936 Mar. 5	8233	10.2	+ 23	+ 37	2	....	......
	7*	8235	10.3	+ 25	+ 32	2	....	......
					+ 32.9			
R Leo								
094211.....	1926 Dec. 14*	4864	6.1	− 8	+ 1	2	+ 10	40
	1927 Dec. 23*	5238	6.6	+ 50	− 8	4	+ 5	28
	1928 Jan. 4*	5250	7.0	+ 62	− 6	5	+ 8	34
	Feb. 11*	5288	8.3	+100	− 3	5	+ 6	13
	1938 Mar 10*	8968	7.0	+ 42	− 3	11	....	......
	Apr. 17*	9006	8.0	+ 80	− 3	11	....	......
	1939 May 7*	9391	9.7	+164	+ 8	4	....	......
					− 1.9		+ 7.4	
S LMi								
094735.....	1929 Feb. 27	5670	(8.6)	....	− 10	2	....	......
	Mar. 1*	5672	(8.3)	....	− 15	3	− 2	40
					− 13.2			
S Sex								
102900.....	1940 Apr. 17	9737	9.8	− 45	− 9	2	....	......
	May 5	9755	9.1	− 27	− 18	3	....	......
	5	9755	9.1	− 27	− 13	3	....	......
	19*	9769	8.9	− 13	− 12	2	....	......
					− 12.8			
R UMa								
103769.....	1939 Dec. 28*	9626	9.0	+ 41	+ 27	3	....	......
W Leo								
104814.....	1937 Jan. 31	8565	11.7	+ 34	+ 45	3	....	......
	1939 Jan. 11	9275	9.4	− 5	(+ 30)	2	....	......
	11	9275	9.4	− 5	+ 32	2	....	......
	13*	9277	9.4	− 3	+ 42	2	....	......
					+ 39.4			

TABLE 1—*Continued*

Star	Date	JD 242	Mag.	Phase (Days)	Velocity (km/sec) Emission	No. Lines	Absorption	No. Lines
S Leo 110506.....	1926 Mar. 29	4604	9.9	−17	+98	2	....	......
	1930 June 12	6140	10.0	−2	(+103)	1	....	......
	13	6141	10.0	−1	(+85)	2	....	......
	14	6142	10.0	0	+100	(3)	....	......
	1939 Apr. 6	9360	11.7	+36	+94	3	....	......
					+96.5			
RU UMa 113639.....	1926 Jan. 25	4541	(10.2)	....	−68	2	....	......
	1929 May 24	5756	(7.4)	....	−59	2	....	......
					−63.4			
X Cen 114441.....	1926 May 28*	4664	7.0	+3	(+27)	2	....	......
	29*	4665	7.0	+4	+28	2	....	......
					+27.8			
R Com 115919.....	1940 March 16*	9705	9.2	−7	−11	2	....	......
	28*	9717	9.4	+5	−18	2	....	......
	29	9718	9.4	+6	−15	3	....	......
					−14.8			
SU Vir 120012.....	1926 Feb. 21	4568	9.5	−8	(+10)	3	....	......
	21	4568	9.5	−8	+13	3	....	......
	1927 Apr. 14	4985	8.9	−1	+13	2	....	......
					+12.1			
T Vir 120905.....	1925 May 5	4276	10.2	−10	+2	2	....	......
	June 7	4309	10.4	+23	+9	2	....	......
	1926 Apr. 30	4636	9.9	+14	+12	2	....	......
					+7.7			
Y Vir 122803.....	1923 Apr. 30*	3540	9.4	0	(−2)	2	....	......
	1925 Feb. 11	4193	10.3	−3	−1	2	....	......
					−1.3			
T UMa 123160.....	1940 Apr. 16*	9736	7.8	−9	−100	3	−90	54
	May 4*	9754	7.9	+9	−101	3	....	......
	19*	9769	8.1	+24	−102	8	−92	56
					−100.9		−90.7	
RS UMa 123459.....	1925 Mar. 4*	4214	10.2	−25	−34	2	....	......
	Apr. 9	4250	9.1	+11	−32	2	....	......
					−33.2			

TABLE 1—*Continued*

Star	Date	JD 242	Mag.	Phase (Days)	Velocity (km/sec) Emission	No. Lines	Absorption	No. Lines
S UMa 123961.....	1923 June 4*	3575	8.0	− 8	− 1	3	(0)	(13)
	July 3*	3604	8.1	+ 21	− 7	3	(− 5)	(14)
	1924 Jan. 22*	3807	8.0	− 19	− 6	3	+ 10	18
	1939 Jan. 12*	9276	7.9	− 6	− 3	4	+ 11	14
					− 4.1		+ 7.7	
U Vir 124606.....	1939 June 8*	9423	8.0	− 11	− 53	4	− 47	65
RV Vir 130212.....	1939 June 7	9422	11.5	− 21	+ 19	2	....	......
	1940 Mar. 29	9718	12.4	+ 9	+ 32	2	....	......
					+ 25.2			
RR UMa 132262.....	1924 Jan. 23	3808	(9.2)	....	− 56	2	....	......
	1932 Mar. 23	6790	(10.2)	....	− 45	2	....	......
	1935 May 18	7941	(10.1)	....	− 45	2	....	......
					− 48.9			
R Hya 132422.....	1924 Feb. 24*	3840	5.0	− 23	(− 22)	2	(− 14)	22
	Mar. 24*	3869	4.0	+ 6	− 16	3	− 9	33
	Apr. 19*	3895	4.6	+ 32	(− 28)	4	(− 20)	25
	May 20*	3926	5.9	+ 63	− 28	4	− 13	28
	June 10*	3947	6.2	+ 84	(− 31)	5	(− 15)	11
	1926 May 17*	4653	6.3	− 45	− 15	2	− 1	20
	26*	4662	5.8	− 36	− 18	2	− 7	45
	27*	4663	5.8	− 35	− 14	2	− 7	41
	30*	4666	5.7	− 32	− 12	2	− 9	30
	June 18*	4685	4.8	− 13	− 12	2	− 4	23
	20*	4687	4.8	− 11	− 12	2	− 6	33
	21*	4688	4.7	− 10	− 23	2	− 10	41
	22*	4689	4.7	− 9	− 29	2	− 15	35
	22*	4689	4.7	− 9	− 30	2	− 17	18
	July 24*	4721	4.7	+ 23	− 17	2	− 5	26
	1927 June 18*	5050	5.9	− 59	− 20	2	(− 11)	22
	19*	5051	5.9	− 58	− 24	2	(− 10)	20
	22*	5054	5.8	− 55	− 22	2	− 13	30
	23*	5055	5.8	− 54	− 15	2	− 9	37
	July 15*	5077	4.9	− 32	− 20	2	− 10	36
	16*	5078	4.9	− 31	− 22	3	(− 12)	15
	1933 June 11*	7235	5.4	+ 43	− 19	7	− 10	33
	1937 Mar. 1	8594	9.5	+184	− 22	8	....	......
	28	8621	9.6	+211	− 25	7	....	......
	29	8622	9.6	+212	− 21	9	....	......
	Apr. 29	8653	8.8	−161	− 12	5	....	......
	1939 Jan. 13*	9277	6.7	+ 57	− 17	9	− 8	55
	May 7*	9391	9.5	+171	− 10	3	....	......
	1940 Jan. 20*	9649	5.9	+ 34	− 16	10	− 8	83
	Mar. 16*	9705	7.7	+ 90	− 17	6	− 14	26
	28*	9717	8.0	+102	− 17	5	....	......
					− 19.2		− 9.4	

TABLE 1—*Continued*

Star	Date	JD 242	Mag.	Phase (Days)	Velocity (km/sec) Emission	No. Lines	Absorption	No. Lines
T UMi 133273.....	1923 June 30*	3601	9.2	+ 20	− 12	2	....	......
	1925 Mar. 1*	4211	9.6	− 3	− 18	2	....	......
					− 15.1			
RT CVn 134434.....	1939 Apr. 4	9358	(12.1)	....	− 22	2	....	......
	6	9360	(12.1)	....	− 18	4	....	......
					− 19.6			
R CVn 134440.....	1939 May 5*	9389	8.0	− 22	− 12	2	....	......
	6*	9390	8.0	− 21	− 14	5	− 5	55
	7*	9391	8.0	− 20	− 12	5	− 2	49
	1940 Mar. 16*	9705	8.2	− 30	− 17	5	− 8	63
	27*	9716	8.0	− 19	− 14	5	− 2	44
					− 13.7		− 4.0	
RX Cen 1345*36*.....	1935 June 13*	7967	9.2	+ 6	− 18	2	....	......
	14*	7968	9.2	+ 7	− 11	3	....	......
					− 14.3			
Z Boo 140113.....	1925 Mar. 1*	4211	9.6	− 15	+ 30	2	....	......
	2*	4212	9.6	− 14	+ 32	2	....	......
					+ 31.2			
Z Vir 1405*12*.....	1928 May 3	5370	11.0	− 5	(+ 56)	2	....	......
	1932 June 20	6879	10.6	− 18	+ 59	2	....	......
					+ 57.8			
RU Hya 1405*28*.....	1936 Mar. 5	8233	9.2	− 16	− 14	2	....	......
	1937 Feb. 28	8593	8.7	+ 13	− 8	2	....	......
					− 11.3			
U UMi 141567.....	1940 May 4*	9754	8.5	− 16	− 37	3	....	......
	5*	9755	8.4	− 15	− 34	8	− 23	55
	28*	9778	8.0	+ 8	− 37	8	− 24	56
	29*	9779	8.1	+ 9	− 41	7	− 32	57
					− 37.3		− 26.3	
R Cam 142584.....	1923 Apr. 7*	3517	8.7	+ 38	(− 49)	2	....	......
V Boo 142539a....	1939 Apr. 6*	9360	7.7	+ 18	− 41	7	− 39	45

TABLE 1—*Continued*

Star	Date	JD 242	Mag.	Phase (Days)	Velocity (km/sec)			
					Emission	No. Lines	Absorption	No. Lines
R Boo 143227.....	1923 Mar. 1*	3480	7.2	−12	−58	5	−56	49
	1924 June 15*	3952	7.1	+17	−73	2	−66	21
	1925 Jan. 5*	4156	8.1	−10	−62	2	....	......
					−64.5		−59.7	
V Lib 1434*17*.....	1940 May 30	9780	11.1	+7	+7	2	....	......
	30	9780	11.1	+7	+8	2	....	......
					+7.4			
RR Boo 144339.....	1929 May 24	5756	(11.2)	....	(−54)	1	....	......
	1934 July 29	7648	(11.0)	....	(−57)	3	....	......
	1936 Mar. 5	8233	(10.2)	....	−50	4	....	......
	6*	8234	(9.9)	....	−52	3	....	......
	7*	8235	(9.9)	....	−57	3	....	......
	7*	8235	(9.9)	....	−50	3	....	......
					−52.9			
U Boo 144918.....	1940 Feb. 19‡	9679	(11.5)	−51	(+14)	2	....	......
	Mar. 28	9717	10.4	−13	+4	2	....	......
	Apr. 16	9736	10.6	+6	(+14)	2	....	......
	17	9737	10.6	+7	(+16)	2	....	......
					+10.2			
RT Lib 1500*18*.....	1928 Apr. 13	5350	8.7	−12	(+26)	3	....	......
	14*	5351	8.7	−11	+32	3	....	......
	1941 May 13	0128	(10.0)	(−18)	+36	2	....	......
					+32.7			
T Lib 1505*19*.....	1939 June 7	9422	11.5	−14	−59	2	....	......
	July 5	9450	11.1	+14	−55	2	....	......
					−56.8			
RW Lib 1517*23*.....	1924 Jan. 22	3807	(8.5)	....	(+139)	2	....	......
	1925 Apr. 9	4250	(9.3)	....	+126	2	....	......
	1926 Apr. 30	4636	(8.5)	....	+126	2	....	......
					+127.9			
X Lib 1530*20*.....	1939 July 6	9451	12.2	+28	(−45)	2	....	......
	1940 May 30	9780	11.5	+23	(−28)	1	....	......
					−39.2			

‡ Dispersion about 115 A/mm at $H\gamma$.

TABLE 1—*Continued*

Star	Date	JD 242	Mag.	Phase (Days)	Velocity (km/sec)			
					Emission	No. Lines	Absorption	No. Lines
U Lib 153620a....	1927 July 13	5075	9.4	+ 7	+ 93	2	....	......
	14*	5076	9.4	+ 8	+ 81	2	....	......
					+ 85.3			
X CrB 154536.....	1926 Apr. 30	4636	9.7	− 18	−114	2	....	......
	May 1	4637	9.7	− 17	−109	2	....	......
	27*	4663	9.2	+ 9	−115	2	....	......
					−113.0			
R Ser 154615.....	1923 Mar. 1*	3480	7.2	+ 10	+ 13	2	+ 22	54
	1924 Mar. 24*	3869	7.3	+ 35	+ 8	2	+ 20	27
					+ 10.6		+ 21.2	
R Lib 154715.....	1937 Mar. 2	8595	10.0	− 9	+ 12	2	....	......
	1940 July 19	9830	11.0±	+ 4	− 2	2	....	......
					+ 5.3			
Z CrB 155229.....	1935 May 18	7941	11.0	− 21	− 79	2	....	......
	June 16	7970	10.4	+ 8	− 92	2	....	......
	17	7971	10.4	+ 9	(− 98)	2	....	......
	1937 June 19	8704	9.4	− 6	− 94	2	....	......
					− 89.4			
RZ Sco 155823.....	1925 Apr. 9	4250	8.7	− 13	−179	2	....	......
	May 5	4276	8.9	+ 13	−179	1	....	......
	1926 Aug. 11	4739	9.3	+ 9	−187	2	....	......
					−181.7			
Z Sco 160021.....	1934 July 28	7647	9.3	+ 3	(− 73)	2	....	......
	1937 June 19	8704	9.1	+ 5	− 62	2	....	......
	30	8715	9.4	+ 16	− 67	2	....	......
					− 65.8			
RU Her 160625.....	1927 Mar. 16*	4956	9.2	− 4	− 41	2	....	......
	Apr. 14*	4985	9.7	+ 25	− 43	1	....	......
					− 41.7			
S Sco 161122b....	1926 Aug. 10	4738	10.8	+ 5	+ 78	1	....	......
	1929 July 18	5811	10.6	+ 13	(+ 68)	2	....	......
	1930 June 14	6142	11.4	− 7	(+ 57)	1	....	......
	July 9	6167	11.4	+ 18	(+ 95)	1	....	......
	1931 July 5	6528	12.0	+ 28	(+ 85)	1	....	......
					+ 76.7			

TABLE 1—*Continued*

Star	Date			JD 242	Mag.	Phase (Days)	Velocity (km/sec)			
							Emission	No. Lines	Absorption	No. Lines
R Sco 161122a....	1929	Feb.	28	5671	10.4	+ 10	− 14	2	....	......
	1931	July	6	6529	11.2	− 16	(− 2)	2	....	......
			29	6552	10.6	+ 7	− 10	2	....	......
			30	6553	10.6	+ 8	− 15	1	....	......
							− 10.6			
W Oph 161607.....	1937	Aug.	28	8774	10.1	+ 20	− 62	2	....	......
			30	8776	10.1	+ 22	− 47	2	....	......
	1939	July	5	9450	11.0	+ 26	− 56	2	....	......
							− 55.0			
U Her 162119.....	1925	May	6*	4277	9.0	− 30	− 48	1	....	......
			7*	4278	9.0	− 29	− 48	1	....	......
		June	7*	4309	7.9	+ 2	− 37	3	− 27	35
		July	6*	4338	8.4	+ 31	− 46	5	− 28	25
	1926	May	28*	4664	9.8	− 52	− 44	1	....	......
		July	25*	4722	7.4	+ 6	− 36	4	− 28	28
			27*	4724	7.5	+ 8	− 49	2	....	......
		Aug.	12*	4740	7.8	+ 24	− 43	2	....	......
			25*	4753	8.2	+ 37	− 49	2	....	......
		Sept.	16*	4775	9.0	+ 59	− 48	2	....	......
			17*	4776	9.0	+ 60	− 47	2	....	......
							− 45.0		− 27.6	
T Oph 162815.....	1937	Apr.	28	8652	9.9	− 10	− 50	2	....	......
			29	8653	9.9	− 9	− 63	2	....	......
	1940	July	20	9831	9.2	+ 53	− 70	2	....	......
							− 61.3			
SS Her 162807.....	1932	May	13	6841	9.1	+ 2	− 46	3	....	......
	1936	Mar.	5	8233	9.8	+ 19	− 44	2	....	......
			7*	8235	9.9	+ 21	− 49	2	....	......
							− 47.1			
S Oph 162816.....	1935	June	17	7971	9.3	− 17	− 20	2	....	......
	1937	May	17	8671	9.2	− 7	− 18	3	....	......
							− 18.7			
R Dra 163266.....	1940	May	5*	9755	7.4	− 6	−140	4	−129	67
			29*	9779	7.7	+ 18	−142	9	−132	65
			30*	9780	7.8	+ 19	−142	8	−133	70
							−141.2		−131.1	

TABLE 1—*Continued*

Star	Date	JD 242	Mag.	Phase (Days)	Velocity (km/sec) Emission	No. Lines	Absorption	No. Lines
UV Her 164012.....	1935 May 18	7941	(8.3)	....	(− 4)	5	....	......
	19*	7942	(8.3)	....	− 19	3	....	......
	June 12*	7966	(8.8)	....	− 15	3	....	......
					− 14.3			
RR Oph 164319.....	1927 May 13	5014	9.2	− 27	+ 53	2	....	......
	1928 Apr. 14*	5351	9.7	+ 6	+ 48	2	....	......
					+ 49.9			
RS Sco 164844.....	1937 June 18	8703	7.3	+ 5	− 6	1	....	......
	18	8703	7.3	+ 5	− 3	1	....	......
	29	8714	7.4	+ 16	− 4	2	....	......
	29	8714	7.4	+ 16	− 9	2	....	......
					− 7.0			
RV Her 165631.....	1937 June 20	8705	9.4	− 6	− 45	2	....	......
	29	8714	9.3	+ 3	− 58	2	....	......
	30	8715	9.3	+ 4	− 45	2	....	......
					− 49.6			
RT Sco 165636.....	1935 Aug. 16	8031	8.4	+ 4	− 67	3	....	......
WZ Dra 165752.....	1933 Apr. 3	7166	(12.2)	....	(− 61)	2	....	......
	1935 June 13*	7967	(10.8)	....	− 58	2	....	......
	14*	7968	(10.8)	....	− 63	2	....	......
					− 60.7			
R Oph 170215.....	1939 July 4*	9449	8.0	+ 12	− 57	2	....	.....
RT Her 170627.....	1937 May 17	8671	9.4	− 4	− 76	2	....	......
	18	8672	9.4	− 3	− 76	2	....	......
					− 75.8			
Z Oph 171401.....	1936 Apr. 7*	8266	9.0	− 40	− 89	3	....	......
RU Oph 172809.....	1937 June 19	8704	9.2	+ 11	− 76	2	....	......
	30	8715	9.4	+ 22	− 72	2	....	......
					− 74.3			
RT Oph 175111.....	1938 June 8	9058	10.5	+ 55	− 58	2	....	......
	1939 July 5	9450	10.2	+ 25	− 50	3	....	......
					− 53.7			

TABLE 1—*Continued*

Star	Date	JD 242	Mag.	Phase (Days)	Velocity (km/sec)			
					Emission	No. Lines	Absorption	No. Lines
V Dra								
175654.....	1937 Mar. 1	8594	(9.2)	+25	−5	2	....	......
	1939 June 7	9422	9.9	+3	(+2)	2	....	......
	8*	9423	9.8	+4	+10	2	....	......
					+5.1			
T Her								
180531.....	1940 July 17*	9828	8.8	+10	−129	4	−122	66
	18*	9829	8.9	+11	−129	4	−123	60
					−128.9		−122.2	
W Dra								
180565.....	1925 May 6*	4277	9.6	+7	(−32)	2	....	......
	7*	4278	9.6	+8	−28	2	....	......
					−29.0			
TV Her								
181031.....	1937 Sept. 23	8800	10.6	−8	−78	2	....	......
	25	8802	10.6	−6	−77	2	....	......
					−77.2			
RV Sgr								
182133.....	1930 June 14	6142	8.1	+12	(+15)	1	....	......
	1937 June 18	8703	8.5	−12	+10	2	....	......
					+12.1			
SV Her								
182224.....	1937 June 19	8704	10.7	+16	−34	2	....	......
	29	8714	10.9	+26	−29	2	....	......
					−31.5			
T Ser								
182306.....	1939 Sept. 1	9508	10.8	−8	−10	2	....	......
	1	9508	10.8	−8	−10	2	....	......
					−10.4			
SV Dra								
183149.....	1937 Apr. 29	8653	11.0	+14	+11	2	....	......
	30	8654	11.0	+15	+18	2	....	......
					+14.6			
RZ Her								
183225.....	1935 Sept. 18	8064	9.4	−11	+42	4	....	......
	1937 July 30	8745	9.6	−1	(+6)	2	....	......
	1938 June 8	9058	9.3	−13	+17	2	....	......
	9	9059	9.3	−12	+20	2	....	......
	1939 May 7	9391	9.5	−6	(+47)	2	....	......
	8	9392	9.5	−5	(+13)	2	....	......
	9	9393	9.5	−4	+20	2	....	......
	June 8*	9423	10.4	+26	+26	2	....	......
					+24.3			
X Oph								
183308.....	1923 Apr. 30*	3540	7.3	+47	−88	2	....	......

TABLE 1—*Continued*

Star	Date			JD 242	Mag.	Phase (Days)	Velocity (km/sec) Emission	No. Lines	Absorption	No. Lines
RS Dra 184074	1939	Oct.	4	9541	(8.8)	....	− 35	2	....	......
			4	9541	(8.8)	....	− 39	2	....	......
							− 37.1			
RY Lyr 184134	1937	June	30	8715	9.4	+ 3	− 27	3	....	......
		Aug.	29	8775	9.6	+ 63	− 37	3	....	......
							− 31.7			
ST Sgr 185512a	1924	Apr.	16	3892	8.9	+ 24	+ 35	3	....	......
	1925	May	5*	4276	9.6	+ 16	+ 30	1	....	......
	1930	Sept.	11	6231	8.0	+ 6	+ 32	3	....	......
			13	6233	8.1	+ 8	(+ 12)	3	....	......
	1940	July	19	9830	10.8	+ 48	+ 24	2	....	......
							+ 28.2			
Z Lyr 185634	1926	Aug.	23	4751	10.4	− 7	− 5	2	....	......
	1935	May	18	7941	11.2	− 31	+ 1	2	....	......
		June	16	7970	9.6	− 2	− 8	4	....	......
							− 4.0			
RT Lyr 185737	1937	Aug.	27	8773	11.8	+ 31	−104	2	....	......
			30	8776	11.9	+ 34	−101	2	....	......
							−102.5			
R Aql 190108	1923	July	29*	3630	8.3	+ 74	+ 12	6	....	......
		Oct.	1*	3694	11.0	+138	+ 22	2	....	......
	1939	May	6*	9390	7.4	+ 36	+ 24	16	+ 36	54
							+ 19.4			
V Lyr 190529a	1926	June	20*	4687	9.7	+ 7	− 37	2	....	......
	1932	Aug.	17*	6937	10.5	+ 7	− 35	2	....	......
							− 36.3			
RX Sgr 190818	1937	Sept.	24	8801	9.8	+ 6	− 32	2	....	......
			25	8802	9.8	+ 7	− 42	2	....	......
							− 36.9			
RU Lyr 190941	1940	Apr.	17	9737	(11.8)	+ 7±	− 18	4	....	......
		May	20	9770	11.6	+ 40±	− 10	4	....	......
							− 14.1			

TABLE 1—*Continued*

Star	Date			JD 242	Mag.	Phase (Days)	Velocity (km/sec) Emission	No. Lines	Absorption	No. Lines
RS Lyr 190933a....	1939	July	5	9450	11.5	−42	−26	2	....	......
			6	9451	11.5	−41	−30	2	....	......
							−27.9			
U Dra 190967.....	1927	Apr.	17*	4988	9.8	+18	−12	2	....	......
	1931	Aug.	1	6555	9.7	−19	(−12)	2	....	......
		Sept.	1*	6586	9.4	+12	−11	2	....	......
							−11.5			
W Aql 191007.....	1928	Apr.	14*	5351	8.2	+13	−40	2	....	......
		May	2	5369	8.3	+31	−32	1	....	......
			3	5370	8.3	+32	−40	3	....	......
							−38.5			
T Sgr 191017.....	1923	July	28*	3629	8.9	+47	−12	2	....	......
		Aug.	30	3662	9.8	+80	−14	3	....	......
	1924	June	12	3949	9.0	−41	(−26)	1	....	......
		July	18	3985	8.1	−5	(−4)	1	....	......
							−13.5			
S Sgr 191319a....	1927	May	13	5014	10.1	−4	+24	2	....	......
	1935	Aug.	16	8031	11.0	+3	+26	2	....	......
							+25.0			
Z Sgr 191321.....	1926	Sept.	18	4777	(10.2)	....	−36	2	....	......
	1935	June	16	7970	7.2±	+3	−32	2	....	......
			18*	7972	7.2±	+5	−37	2	....	......
							−35.3			
W Sge 191517a....	1935	Aug.	12	8027	(9.9)	....	−78	2	....	......
			15	8030	(9.9)	....	(−65)	2	....	......
							−73.6			
R Cyg 193449.....	1937	Aug.	22*	8768	8.0	−9	−48	3	....	......
RV Aql 193509.....	1935	June	17	7971	10.0	−3	−86	2	....	......
		July	15*	7999	10.0	+25	−82	3	....	......
							−83.8			
RT Cyg 194048.....	1940	May	18*	9768	8.0	+2	−125	11	−116	39
			19*	9769	8.0	+3	−126	17	−115	53
							−125.5		−115.9	

TABLE 1—*Continued*

Star	Date	JD 242	Mag.	Phase (Days)	Velocity (km/sec) Emission	No. Lines	Absorption	No. Lines
TU Cyg 194348	1935 Sept. 18	8064	9.8	0	(− 91)	2	....	......
	19	8065	9.8	+ 1	− 90	2	....	......
					− 90.4			
X Aql 194604	1932 Aug. 17*	6937	9.4	− 21	+ 9	2	....	......
	1935 June 13*	7967	9.4	− 12	+ 2	2	....	......
	17	7971	9.0	− 8	+ 15	2	....	......
					+ 9.9			
χ Cyg 194632	1923 Sept. 6*	3669	7.6	− 61	− 8	2	+ 2	40
	30*	3693	6.0	− 37	− 7	2	− 3	71
	Oct. 25*	3718	4.7	− 12	− 18	2	− 8	62
	1928 Apr. 13*	5350	5.5	− 23	− 10	3	+ 4	36
	15*	5352	5.4	− 21	− 12	3	+ 4	38
	15*	5352	5.4	− 21	− 21	3	− 5	35
	15*	5352	5.4	− 21	− 12	3	+ 3	33
	July 5*	5433	7.1	+ 60	− 14	4	....	......
	6*	5434	7.2	+ 61	− 20	5	− 5	38
	1937 Oct. 25	8832	12.2	+161	(− 5)	3	....	......
	1938 July 9*	9089	5.3	+ 14	− 14	5	− 1	71
	Aug. 6§	9117	6.3	+ 42	− 25	2	....	......
	7‖	9118	6.3	+ 43	− 26	2	....	......
	8*	9119	6.4	+ 44	− 19	16	− 4	34
	Sept. 3‖	9145	7.4	+ 70	− 25	2	....	......
	1938 Sept. 6*	9148	7.5	+ 73	− 21	18	− 8	32
	Nov. 3	9206	10.5	+131	− 13	5	....	......
	1939 July 6*	9451	7.6	− 47	− 12	5	+ 8	25
	29*	9474	6.3	− 24	− 10	3	+ 11	45
	Aug. 31*	9507	5.5	+ 9	− 14	7	− 1	54
	Oct. 5*	9542	7.2	+ 44	− 9	11	+ 3	42
	23*	9560	8.3	+ 62	− 8	10	+ 2	17
					− 14.9		+ 0.1	
RR Sgr 194929	1926 Sept. 18	4777	6.5	+ 27	(+ 76)	2	....	......
	19*	4778	6.5	+ 28	+ 70	3	....	......
					+ 71.1			
RU Sgr 195142	1935 June 14*	7968	7.1	+ 1	− 69	3	....	......
	July 17*	8001	8.0	+ 34	− 80	2	....	......
					− 76.5			
RR Aql 195202	1926 Aug. 23	4751	10.4	− 9	(+ 2)	2	....	......
	1937 June 18	8703	8.8	− 10	+ 3	2	....	......
	1939 Oct. 3	9540	9.6	+ 32	− 2	2	....	......
					+ 1.0			

§ Dispersion about 10 A/mm.
‖ Dispersion about 2.9 A/mm.

TABLE 1—*Continued*

Star	Date	JD 242	Mag.	Phase (Days)	Velocity (km/sec) Emission	No. Lines	Absorption	No. Lines
RS Aql 1953*08*	1937 Apr. 30	8654	11.0	+ 54	− 5	1	....	......
	1940 Aug. 23	9865	10.6	+ 23	− 15	2	....	......
	24	9866	10.6	+ 24	− 17	2	....	......
					− 13.8			
SY Aql 200212	1937 Aug. 27	8773	8.6	+ 18	− 91	3	....	......
	29	8775	8.6	+ 20	− 84	3	....	......
	29	8775	8.6	+ 20	− 86	2	....	......
	Sept. 24	8801	9.3	+ 46	− 69	2	....	......
					− 82.6			
S Cyg 200357	1926 Aug. 10	4738	10.6	− 1	− 26	3	....	......
S Aql 200715a	1927 July 7*	5069	9.2	− 22	(−130)	2	....	......
	13*	5075	9.2	− 16	−120	3	....	......
	14*	5076	9.2	− 15	−115	3	....	......
					−119.7			
RU Aql 200812	1925 June 7*	4309	9.2	− 8	+ 17	2	....	......
	1927 Sept. 17*	5141	10.1	− 5	+ 8	2	....	......
					+ 12.5			
W Cap 2008*22*	1939 Sept. 1	9508	11.9	− 11	+ 5	2	....	......
RT Sgr 2011*39*	1926 June 20*	4687	7.6	+ 5	+ 27	2	....	......
	21*	4688	7.6	+ 6	+ 19	1	....	......
					+ 24.3			
SX Cyg 201130	1935 Aug. 12	8027	10.0	− 22	− 22	2	....	......
	15	8030	10.0	− 19	− 23	2	....	......
					− 22.3			
Z Del 202817	1923 Nov. 28	3752	8.6	− 12	+ 24	3	....	......
	1925 Sept. 2	4396	8.9	+ 21	+ 24	3	....	......
	30	4424	10.4	+ 49	+ 19	3	....	......
					+ 22.3			
ST Cyg 202954	1937 Oct. 24	8831	10.1	− 16	− 30	2	....	......
	26	8833	10.0	− 14	− 25	2	....	......
					− 27.3			

TABLE 1—*Continued*

Star	Date	JD 242	Mag.	Phase (Days)	Velocity (km/sec) Emission	No. Lines	Absorption	No. Lines
R Mic 203429	1925 July 5	4337	10.4	+18	(+ 4)	1	....	......
	1938 Oct. 11	9183	9.4	+20	+ 4	2	....	......
					+ 4.4			
RU Vul 203422	1940 Aug. 23	9865	9.5	+23	−96	2	....	......
	24	9866	9.5	+24	−91	2	....	......
					−93.4			
S Del 203816	1937 May 16	8670	9.8	−40	−19	2	....	......
	June 29	8714	9.0	+ 4	−22	2	....	......
					−20.6			
T Del 204016	1926 July 24*	4721	9.5	+25	−19	2	....	......
	27*	4724	9.5	+28	−21	2	....	......
					−19.8			
W Aqr 204104	1930 July 9	6167	9.7	+27	−29	2	....	......
	Aug. 6*	6195	10.6	+55	−22	1	....	......
	1931 July 2*	6525	8.9	+ 5	−33	2	....	......
					−29.3			
V Del 204318	1936 July 2*	8352	10.3	− 4	−39	2	....	......
T Aqr 204405	1940 July 17*	9828	8.2	− 4	−49	3	−37	57
	18*	9829	8.2	− 3	−51	3	−42	36
					−50.0		−39.7	
UX Cyg 205030a	1935 June 12*	7966	10.0	+ 1	−18	2	....	......
	July 15*	7999	10.8	+34	−23	1	....	......
					−19.7			
RR Cap 205627	1935 July 17*	8001	(9.2)	....	−71	2	....	......
	Aug. 16	8031	(9.2)	....	−70	2	....	......
					−70.7			
V Cap 210124	1931 Sept. 3	6588	9.1	+ 8	(−41)	2	....	......
	1940 Oct. 14	9917	9.5	− 2	−44	2	....	......
	14	9917	9.5	− 2	−45	2	....	......
					−43.8			

TABLE 1—*Continued*

Star	Date	JD 242	Mag.	Phase (Days)	Velocity (km/sec) Emission	No. Lines	Absorption	No. Lines
X Cep								
210382.....	1937 Sept. 17	8794	10.5	−29	+18	1	....	......
	1940 Aug. 24	9866	9.6	−20	+11	2	....	......
	Sept. 9	9882	10.0	−4	0	2	....	......
	10	9883	10.0	−3	+4	2	....	......
					+6.8			
Z Cap								
210516.....	1940 Aug. 24	9866	9.5	−9	−73	2	....	......
	24	9866	9.5	−9	−72	2	....	......
					−72.5			
X Peg								
211614.....	1937 Aug. 27	8773	9.7	+6	−60	2	....	......
	28	8774	9.7	+7	−72	2	....	......
					−66.2			
T Cap								
211615.....	1926 July 26*	4723	10.1	+31	+34	1	....	......
	1935 July 16*	8000	(10.8)	+28	+35	2	....	......
					+34.6			
S Mic								
212030.....	1937 Sept. 23	8800	9.3	+32	(+35)	2	....	......
	1938 Oct. 11	9183	9.3	+3	+40	2	....	......
					+39.0			
RR Peg								
214024.....	1926 July 24*	4721	9.5	+21	−40	2	....	......
	25*	4722	9.5	+22	−35	2	....	......
					−37.2			
V Peg								
215605.....	1927 Oct. 13	5167	9.6	+9	−30	2	....	......
	14*	5168	9.6	+10	−38	2	....	......
					−35.4			
RT Peg								
215934.....	1938 Nov. 7	9210	12.5	−19	−122	2	....	......
	1940 Aug. 23	9865	10.3	−15	(−126)	2	....	......
	24	9866	10.3	−14	−132	2	....	......
	24	9866	10.3	−14	−124	2	....	......
					−125.9			
Y Peg								
220613.....	1937 Aug. 29	8775	12.0	+32	−95	2	....	......
RS Peg								
220714.....	1937 June 30	8715	10.6	+76	−47	2	....	......
	30	8715	10.6	+76	−45	2	....	......
					−46.0			

TABLE 1—*Continued*

Star	Date	JD 242	Mag.	Phase (Days)	Velocity (km/sec) Emission	No. Lines	Absorption	No. Lines
X Aqr 221321	1935 July 15*	7999	(9.2)	− 20	− 1	2	....	......
	Aug. 12	8027	(8.3)	+ 8	− 2	2	....	......
					− 1.4			
T Gru 221938	1927 Oct. 13	5167	8.9	+ 18	+ 4	1	....	......
	1937 Oct. 26	8833	11.0±	+ 23	− 4	2	....	......
	26	8833	11.0±	+ 23	(− 9)	1	....	......
					− 4.3			
RV Peg 222129	1935 June 12*	7966	10.3	+ 39	− 43	1	....	......
	16	7970	10.4	+ 43	− 48	1	....	......
					− 46.2			
SS Peg 222924	1934 Sept. 28*	7709	(10.3)	....	− 34	2	....	......
	1935 Oct. 7*	8083	(9.2)	....	− 29	4	....	......
	Nov. 10	8117	(10.3)	....	− 31	5	....	......
					− 31.4			
TV And 225342	1940 Aug. 15	9857	10.6	− 43	− 60	2	....	......
RW Peg 225914	1937 Sept. 23	8800	10.6	+ 21	− 89	2	....	......
	24	8801	10.6	+ 22	− 82	2	....	......
					− 85.8			
R Peg 230110	1926 June 20*	4687	8.9	+ 25	+ 8	2	....	......
	21*	4688	8.9	+ 26	+ 5	2	....	......
					+ 6.3			
Z Cas 233956	1932 Oct. 11*	6992	10.0	+ 26	− 48	2	....	......
	Nov. 15*	7027	11.2	+ 61	− 44	2	....	......
					− 46.3			
Z Aqr 234716	1935 July 19*	8003	9.3	− 37	+ 64	1	....	......
	20*	8004	9.3	− 36	+ 62	2	....	......
					+ 62.7			
RR Cas 235053	1938 Oct. 11	9183	10.8	+ 18	− 58	2	....	......
	Nov. 7	9210	11.8	+ 45	− 54	2	....	......
					− 56.1			

TABLE 1—*Continued*

Star	Date	JD 242	Mag.	Phase (Days)	Velocity (km/sec) Emission	No. Lines	Absorption	No. Lines
R Cas								
235350.....	1926 June 21*	4688	6.1	− 1	+ 10	2	+ 29	18
	22*	4689	6.1	0	+ 11	2	+ 27	23
	July 25*	4722	7.4	+ 33	+ 12	3	+ 25	27
	Oct. 22*	4811	9.4	+122	+ 7	5	(+ 26)	8
	1927 Sept. 10*	5134	7.0	+ 11	+ 11	2	+ 22	37
	16*	5140	7.1	+ 17	(+ 3)	2	(+ 18)	17
	1928 Oct. 5*	5525	7.4	− 31	+ 12	2	+ 21	39
	6*	5526	7.3	− 30	+ 15	2	+ 27	29
	1939 June 8*	9423	6.1	− 3	+ 13	4	+ 27	43
	July 6*	9451	7.3	+ 25	+ 13	10	+ 30	49
	29*	9474	7.7	+ 48	+ 11	7	+ 25	44
	Aug. 31*	9507	8.4	+ 81	+ 9	13	....	......
					+ 10.9		+ 25.9	
Z Peg								
235525.....	1926 Sept. 17*	4776	9.1	− 7	− 44	2	....	......
	1927 Aug. 11*	5104	8.3	− 16	− 43	2	....	......
					− 43.6			
W Cet								
235715.....	1927 Oct. 13	5167	9.3	− 47	+ 6	2	....	......
	Nov. 10	5195	8.5	− 19	− 4	2	....	......
	11*	5196	8.5	− 18	− 4	3	....	......
	1928 Nov. 30	5581	8.6	+ 8	− 2	2	....	......
					− 1.7			
Y Cas								
235855.....	1926 Aug. 11	4739	10.0±	− 39	− 24	2	....	......
	23	4751	10.0±	− 27	− 29	2	....	......
					− 26.2			

NOTES TO TABLE 1

It is of interest to compare the notes on the bright hydrogen lines with the remarks in the *Henry Draper Catalogue.*

000451, SS Cas. M5e. Bright $H\gamma$ and $H\delta$ are outstanding.

004132, RW And. On the first two plates the approximate intensities of bright $H\beta$, $H\gamma$, and $H\delta$ are 2, 3, and 6, respectively; on the third plate 0, 1, and 5. The ratio $H\gamma:H\delta$ appears at times to be unusually low.

004746a, RV Cas. Bright $H\gamma$ is scarcely visible although $H\delta$ is outstanding.

0101*02*, Z Cet. Observations at Harvard and Mount Wilson indicate that the type varies from M1e to M6e.

0346*25*, U Eri. The approximate intensities of bright $H\beta$, $H\gamma$, and $H\delta$ are 1, 5, and 2, respectively.

044617, V Tau. On the four plates the types are, respectively, M4e, Moe, M2e, M4e. The range in velocity seems unduly large. Perhaps the velocity decreases rapidly after maximum light.

055646a, RS Aur. Does the velocity decrease after maximum?

060643, RR Aur. The dark lines seem unusually weak. The bright lines are outstanding.

070109, V CMi. The ratio of intensity of the bright lines $H\gamma:H\delta$ is unusually low.

071201, RR Mon. The dark lines λ 4077, λ 4215, *Sr* II, are unusually intense.

0728*20*b, Z Pup. Observations at Harvard and Mount Wilson show that the type varies from M4e to M7e.

073723, S Gem. On the first plate, phase −34 days, the type is M8e.

083350, X UMa. In April, 1936, the approximate intensities of the bright lines $H\beta$, $H\gamma$, and $H\delta$ were 0, 3, and 3, respectively; on March 28, 1921, they were 3, 4, and 3.

0900*24*, S Pyx. The velocity may vary.

102900, S Sex. On the first plate, phase −45 days, the type is more advanced and the bright $H\beta$ line relatively weaker than on the other plates.

104814, W Leo. On the first plate, although at phase +34 days, bright $H\delta$ is at least five times as intense as $H\gamma$. The *TiO* band absorption is very strong.

143227, R Boo. The Ann Arbor and Mount Wilson observations offer some evidence of algebraically lower velocity after maximum light.

1500*18*, RT Lib. On the first two plates *AlO* band heads at λ 4648 and λ 4842 (in absorption) are more intense than in any other star observed, while bright $H\beta$ is unusually strong. On the last plate the spectrum is a normal one of class M5e, $H\beta$ being weak or absent.

1611*22*b, S Sco. The lines on all plates except the first are badly underexposed, and the measures are unreliable.

1628*15*, T Oph. The first and last plates are of slightly inferior quality, and it is not certain that the difference in velocity is significant.

164012, UV Her. The first plate is strongly exposed, and the discordance of its velocity may not be significant.

1656*36*, RT Sco. Bright $H\beta$ is unusually intense.

183225, RZ Her. The velocities are discordant, and there are some peculiarities in the behavior of individual lines. An investigation of the bright lines with the 18-inch camera might prove valuable.

1855*12*a, ST Sgr. On the last plate, phase +48 days, the *TiO* bands are very strong. The behavior of the spectrum may resemble that of T Geminorum.

194048, RT Cyg. The absorption spectrum bears a strong resemblance to that of α Orionis, although differing in certain details. λ 4227 *Ca* I is very narrow and sharp. A photograph of the ultraviolet bright lines is reproduced in *Mt. W. Contr.*, No. 642; *Ap. J.*, **93**, 40, 1941.

1951*42*, RU Sgr. The difference in velocity may be intrinsic. In other variables the velocity from the bright lines has been found to decrease algebraically after maximum light.

200212, SY Aql. The divergence of velocity shown by the last plate may possibly be real. If so, the usual tendency for the velocity to decrease algebraically after maximum is reversed in this star. The observation needs confirmation. The bright lines are very strong on all the exposures.

220714, RS Peg. The post-maximum bright lines λλ 4202, 4308, 4376, and 4571 are visible. All except λ 4202 are of low intensity.

The numbers of spectrograms obtained at various apparent magnitudes in three extensive programs are shown in Table 2.

TABLE 2

NUMBERS OF SPECTROGRAMS AT VARIOUS APPARENT MAGNITUDES

Apparent Magnitude	Ann Arbor	Mt. Wilson 1919–1923	Mt. Wilson 1924–1940	Total
Brighter than 7.0...	26	35	55	116
7.0– 7.9.........	45	99	65	209
8.0– 8.9.........	56	149	125	330
9.0– 9.9.........	0	53	191	244
10.0–10.9.........	0	10	127	137
Fainter than 10.9...	0	2	55	57
Sum..........	127	348	618	1093

COLLECTED RADIAL-VELOCITY DATA

The velocities in Table 3 summarize all known measurements. The chief sources, in addition to Table 1 of the present *Contribution*, are:

P. W. MERRILL, *Pub. Obs. Univ. of Mich.*, **2**, 45, 1916; and *Mt. W. Contr.*, No. 264; *Ap. J.*, **58**, 215, 1923. (These two articles include references to early measurements by other observers.)
EDWIN B. FROST and FRANCES LOWATER, *Ap. J.*, **58**, 265, 1923 (*o* Cet, R Leo, T Cep, R Ser).
LEAH B. ALLEN, *Lick Obs. Bull.*, **12**, 71, 1925 (20 southern variables).
A. H. JOY, *Mt. W. Contr.*, No. 311; *Ap. J.* **63**, 281, 1926 (*o* Cet).
P. W. MERRILL and A. H. JOY, *Mt. W. Contr.*, No. 382; *Ap. J.*, **69**, 379, 1929 (R Vir).
P. W. MERRILL and C. G. BURWELL, *Mt. W. Contr.*, No. 399; *Ap. J.*, **71**, 285, 1930.
A. H. JOY and P. W. MERRILL, *Mt. W. Contr.*, No. 559; *Ap. J.*, **85**, 9, 1937 (R CVn).

The galactic co-ordinates, l and b, are based on the pole $\alpha = 12^h\ 40^m$, $\delta = +28°$ (1900). The recorded spectral type represents the probable average type at maximum light; for many stars both the Harvard records and the Mount Wilson observations have been taken into consideration. The photometric data, "Period" and "Magnitude at Maximum," were supplied from the Harvard Observatory through the courtesy of Dr. Harlow Shapley and Mr. Leon Campbell. The emission-line velocities and the absorption-line velocities not in parenthesis are direct measurements. The absorption-line velocities in parenthesis were derived from measurements of the emission lines in the manner described in *Mt. W. Contr.*, No. 644.[3] It is recommended that the absorption velocities be used in all studies of the galactic motions of long-period variables. The last column, "Residual Velocity," is the absorption-line velocity corrected for the standard solar motion, 20 km/sec, toward $\alpha = 270°$, $\delta = +30°$.

As far as physical characteristics are concerned, the objects included in Table 3 are believed to constitute a fair sample of long-period variables of spectral classes Me and Se. The spatial distribution is less satisfactory because of the small number of stars observed in extreme southern declinations. The velocities of 20 southern objects obtained by the Chile station of the Lick Observatory[2] are very valuable. I am indebted to W. W. Campbell, late director of the Lick Observatory, for these observations which were obtained at my request many years ago. Velocities for 40 additional variables south of declination $-40°$ would still further strengthen the whole statistical discussion.

TABLE 3

RADIAL VELOCITIES OF LONG-PERIOD VARIABLES

No.	Star	Desig.	*l*	*b*	Spec.	Period (Days)	Mag. at Max.	Velocity (km/sec) Em.	Abs.	Resid.
1......	SS Cas	000451	84°	−11°	M4e	142	8.5	− 25	(− 19)	− 11
2......	S Scl	001032	322	−82	M6e	366	6.9	+ 14	+ 35	+ 29
3......	X And	001046	85	−15	Se	346	9.0	− 18	(− 4)	+ 3
4......	T And	001726	84	−35	M4e	281	8.5	− 95	− 90	− 87
5......	T Cas	001755	87	− 7	M8e	445	8.2	− 24	− 12	− 5
6......	R And	001838	85	−24	Se	409	6.9	− 29	− 8	− 2
7......	S Cet	001909	74	−71	M3e	321	8.2	+ 20	(+ 33)	+ 30
8......	Y Cep	003179	90	+18	M5e	333	9.5	− 13	(0)	+ 9
9......	U Cas	004047	90	−14	Se	278	8.4	− 55	− 45	− 40
10......	RW And	004132	90	−30	M5e	431	8.8	− 30	(− 15)	− 12
11......	V And	004435	91	−27	M2e	258	9.2	+ 8	(+ 16)	+ 19
12......	RR And	004533	91	−28	M5e	329	9.2	− 85	(− 71)	− 68
13......	RV Cas	004746	91	−15	M(7)e	331	9.2	− 80	(− 67)	− 62
14......	W Cas	004958	91	− 4	Se	406	8.8	− 58	(− 39)	− 32
15......	Z Cet	010102	102	−64	M(2)e	184	8.8	− 6	(+ 3)	− 2
16......	X Psc	010621	98	−40	M6e	352	8.0	− 3	(+ 11)	+ 10
17......	U And	010940	96	−21	M6e	347	9.9	− 19	(− 4)	− 2
18......	UZ And	011041	96	−20	M7e	314	10.1	− 51	(− 39)	− 36
19......	S Cas	011272	92	+10	Se	612	8.3	− 53	(− 32)	− 24
20......	RZ Per	012350	97	−11	Se	354	9.5	− 26	(− 10)	− 6
21......	R Psc	012502	112	−58	M4e	344	8.2	− 59	(− 45)	− 51
22......	SX And	012746	99	−15	M6e	335	9.1	− 82	(− 69)	− 66
23......	Y And	013338	101	−23	M3e	220	9.4	− 17	(− 7)	− 6
24......	U Per	015254	101	− 6	M6e	318	8.1	+ 8	+ 17	+ 21
25......	S Ari	015912	118	−46	M4e	295	10.9	− 37	(− 27)	− 33
26......	R Ari	021024	115	−33	M3e	187	8.2	+102	+114	+110
27......	W And	021143	107	−15	M8e	397	7.3	− 45	− 28	− 28
28......	*o* Cet	021403	137	−57	M6e	331	3.4	+ 48	+ 64	+ 54
29......	R Cet	022000	136	−54	M4e	167	8.1	+ 32	+ 42	+ 32
30......	RR Per	022150	106	− 8	M6e	391	8.9	− 5	(+ 9)	+ 10
31......	U Cet	022813	156	−61	M3e	235	7.5	− 39	− 27	− 39
32......	R Tri	023133	115	−23	M4e	266	6.0	+ 60	+ 67	+ 63
33......	R Hor	025050	231	−57	M7e	401	6.4	+ 47	+ 59	+ 44
34......	U Ari	030514	134	−35	M5e	370	8.2	− 51	(− 37)	− 47
35......	X Cet	031401	151	−45	M2e	176	8.8	+ 51	(+ 59)	+ 46
36......	R Per	032335	124	−16	M3e	210	8.6	− 89	− 78	− 84
37......	U Eri	034625	187	−49	M4e	273	8.4	− 43	(− 35)	− 52
38......	T Eri	035124	186	−47	M4e	252	8.3	+ 34	(+ 42)	+ 25
39......	W Eri	040725	189	−44	M7e	375	8.7	+ 11	(+ 26)	+ 8
40......	R Tau	042209	153	−24	M5e	324	8.9	+ 19	(+ 32)	+ 18
41......	S Tau	042309	153	−24	M7e	373	9.6	+ 26	(+ 40)	+ 26
42......	T Cam	043065	111	+14	Se	373	8.1	− 19	(− 2)	0
43......	R Ret	043263	241	−39	M4e	277	7.6	+ 18	(+ 26)	+ 10
44......	RX Tau	043208	156	−23	M7e	337	9.3	− 36	(− 22)	− 36
45......	X Cam	043274	104	+19	M3e	143	8.2	− 6	(0)	+ 5

TABLE 3—*Continued*

No.	Star	Desig.	*l*	*b*	Spec.	Period (Days)	Mag. at Max.	Velocity (km/sec)		
								Em.	Abs.	Resid.
46......	R Pic	044349	223	−40	M1e	170	6.7	+208	+204	+186
47......	V Tau	044617	150	−15	M2e	170	9.2	+ 70	(+ 78)	+ 65
48......	R Ori	045307	160	−19	Se	379	9.5	+ 19	(+ 36)	+ 21
49......	T Lep	050022	190	−31	M7e	367	8.4	− 18	(− 4)	− 23
50......	V Ori	050003	164	−20	M3e	268	9.4	+ 14	(+ 22)	+ 6
51......	R Aur	050953	124	+10	M7e	458	8.0	− 10	+ 8	+ 6
52......	T Col	051533	204	−32	M4e	225	7.5	+ 56	+ 66	+ 46
53......	AC Aur	051950	128	+ 9	M5e	314	8.6	− 33	(− 21)	− 24
54......	W Aur	052036	139	+ 2	M3e	274	9.2	−140	(−132)	−140
55......	S Ori	052404	175	−19	M7e	416	7.9	+ 8	(+ 22)	+ 4
56......	RU Aur	053337	140	+ 5	M8e	462	9.5	− 52	(− 38)	− 46
57......	U Aur	053531	145	+ 2	M7e	408	8.6	+ 7	+ 15	+ 6
58......	S Col	054331	204	−26	M6e	325	9.2	+ 60	(+ 73)	+ 53
59......	R Col	054629	202	−24	M3e	327	9.1	+ 57	(+ 70)	+ 50
60......	U Ori	054920	156	− 1	M8e	373	6.0	− 34	− 22	−34
61......	RS Aur	055646	134	+13	M4e	172	8.6	+ 9	(+ 17)	+ 12
62......	R Oct	055686	266	−29	M6e	406	8.0	+ 31	+ 46	+ 35
63......	X Aur	060450	131	+16	M3e	163	8.3	− 26	(− 18)	− 22
64......	RR Aur	060443	138	+13	M3e	308	9.0	+ 14	(+ 25)	+ 19
65......	V Mon	061702	179	− 6	M5e	334	7.2	+ 16	(+ 30)	+ 12
66......	U Lyn	063159	123	+23	M(8)e	438	9.7	− 30	(− 16)	− 16
67......	S Lyn	063558	125	+23	M7e	301	9.4	− 22	(− 11)	− 12
68......	X Gem	064030	153	+14	M5e	264	8.2	+ 67	(+75)	+ 65
69......	Y Mon	065111	171	+ 8	M4e	230	9.1	+ 61	(+ 71)	+ 56
70......	X Mon	065208	189	− 1	M3e	156	7.3	+153	+160	+142
71......	R Lyn	065355	128	+25	Se	379	8.0	+ 10	(+ 28)	+ 26
72......	R Gem	070122	162	+15	Se	370	7.1	− 56	− 40	− 52
73......	V CMi	070109	174	+ 9	M6e	366	8.9	+ 23	(+ 37)	+ 22
74......	R CMi	070310	174	+10	Se	338	7.9	+ 34	(+ 48)	+ 33
75......	L_2 Pup	071044	223	−14	M5e	141	4.0	+ 49	+ 53	+ 34
76......	RR Mon	071201	183	+ 8	M6e	393	9.5	+ 14	(+ 28)	+ 12
77......	V Gem	071713	172	+14	M4e	275	8.3	+ 11	+ 22	+ 8
78......	S CMi	072708	178	+14	M7e	333	7.5	+ 55	(+ 68)	+ 54
79......	Z Pup	072820	204	+ 1	M6e	512	7.5	+ 12	(+ 26)	+ 8
80......	T CMi	072811	175	+16	M(5)e	319	9.4	+ 23	(+ 35)	+ 21
81......	U CMi	073508	179	+16	M4e	411	8.8	+ 42	(+ 56)	+ 42
82......	S Gem	073723	165	+22	M5e	293	8.8	+101	(+111)	+100
83......	W Pup	074241	224	− 8	M3e	121	8.4	+ 13	(+ 17)	− 1
84......	T Gem	074323	165	+24	Se	288	8.7	+ 11	(+ 22)	+ 12
85......	U Pup	075612	200	+10	M6e	316	10.3	− 13	(− 1)	− 18
86......	R Cnc	081112	180	+26	M7e	361	6.8	+ 19	+ 32	+ 20
87......	V Cnc	081617	174	+29	Se	272	7.7	− 12	(− 1)	− 12
86......	RT Hya	082405	198	+20	M6e	252	7.1	+ 35	+ 40	+ 25
89......	U Cnc	083019	174	+33	M2e	305	9.4	+ 61	(+ 72)	+ 62
90......	X UMa	083350	136	+39	M4e	248	9.5	− 91	(− 83)	− 84

TABLE 3—*Continued*

No.	Star	Desig.	*l*	*b*	Spec.	Period (Days)	Mag. at Max.	Velocity (km/sec) Em.	Abs.	Resid.
91......	S Hya	084803	193	+30	M4e	256	7.9	+ 66	(+ 74)	+ 62
92......	T Hya	0850*08*	205	+24	M3e	289	7.9	− 12	(− 3)	− 17
93......	S Pyx	0900*24*	220	+15	M3e	207	8.2	+ 90	(+100)	+ 85
94......	W Cnc	090425	170	+42	M7e	392	8.2	+ 35	(+ 49)	+ 42
95......	R Car	0929*62*	250	− 8	M5e	309	4.4	+ 16	+ 28	+ 14
96......	X Hya	0930*14*	216	+28	M7e	302	8.7	+ 29	+ 42	+ 29
97......	Y Dra	093178	101	+36	M5e	326	9.0	+ 10	(+ 23)	+ 31
98......	R LMi	093934	158	+51	M8e	372	7.0	− 3	+ 10	+ 7
99......	RR Hya	0940*23*	225	+23	M4e	343	8.4	+ 33	(+ 47)	+ 34
100......	R Leo	094211	192	+46	M8e	313	5.9	− 2	+ 12	+ 4
101......	S LMi	094735	157	+53	M4e	235	8.5	− 13	− 2	− 4
102......	V Leo	095421	180	+52	M(5)e	273	9.0	− 31	(− 23)	− 28
103......	S Car	1006*61*	252	− 4	K5e	149	5.3	+278	+289	+276
104......	S Sex	102900	216	+48	M3e	267	9.2	− 13	(− 5)	− 12
105......	R UMa	103769	105	+45	M4e	301	7.5	+ 25	+ 34	+ 41
106......	W Leo	104814	202	+61	M7e	386	9.4	+ 39	(+ 54)	+ 51
107......	S Leo	110506	220	+59	M(3)e	189	10.0	+ 96	(+106)	+103
108......	RU UMa	113639	136	+73	M3e	252	8.5	− 63	(− 55)	− 50
109......	X Cen	1144*41*	259	+20	M6e	314	7.4	+ 28	(+ 40)	+ 32
110......	Z UMa	115158	102	+58	M6e	190	7.0	− 58	− 53	+ 44
111......	R Com	115919	221	+77	M5e	362	8.4	− 17	(− 3)	0
112......	SU Vir	120012	236	+72	M3e	210	9.3	+ 12	(+ 22)	+ 24
113......	T Vir	1209*05*	256	+56	M6e	339	9.4	+ 8	(+ 22)	+ 22
114......	R Crv	1214*18*	262	+43	M5e	317	7.4	− 34	(− 22)	− 24
115......	Y Vir	1228*03*	265	+58	M(5)e	218	9.4	− 1	(+ 9)	+11
116......	T UMa	123160	92	+58	M4e	257	8.0	−103	− 91	− 81
117......	R Vir	123307	265	+69	M4e	145	6.9	− 37	− 25	− 22
118......	RS UMa	123459	91	+59	M4e	260	8.9	− 33	(− 26)	− 16
119......	S UMa	123961	90	+56	Se	226	7.9	− 4	+ 8	+ 18
120......	U CVn	124238	87	+79	M7e	347	*8.0*	− 44	(− 30)	− 21
121......	U Vir	124606	274	+68	M4e	207	8.1	− 56	− 46	− 41
122......	RV Vir	1302*12*	278	+49	M(5)e	269	10.1	+ 25	(+ 33)	+ 35
123......	V CVn	131546	71	+71	M5e	192	6.8	− 7	− 2	+ 9
124......	RR UMa	132262	82	+54	M4e	229	9.3	− 49	(− 39)	− 27
125......	V Vir	1322*02*	290	+58	M(5)e	250	8.6	+ 25	(+ 33)	+ 39
126......	R Hya	1324*22*	283	+38	M7e	405	4.2	− 19	− 6	− 4
127......	S Vir	1327*06*	290	+53	M7e	377	7.0	− 5	(+ 10)	+ 15
128......	T UMi	133273	85	+44	M5e	316	9.1	− 15	(− 3)	+ 8
129......	T Cen	1336*33*	283	+27	Moe	91	6.1	+ 24	+ 25	+ 25
130......	W Hya	1343*27*	287	+32	M8e	372	7.1	+ 28	+ 42	+ 45
131......	RT CVn	134434	28	+75	M5e	254	10.0	− 20	(− 12)	0
132......	R CVn	134440	46	+72	M6e	326	7.6	− 20	− 6	+ 7
133......	RX Cen	1345*36*	284	+24	M5e	327	8.6	− 14	(− 1)	− 1
134......	Z Boo	140113	328	+66	M5e	281	9.3	+ 31	(+ 40)	+ 51
135......	Z Vir	1405*12*	300	+44	M(5)e	307	9.9	+ 58	(+ 68)	+ 75

TABLE 3—*Continued*

No.	Star	Desig.	*l*	*b*	Spec.	Period (Days)	Mag. at Max.	Velocity (km/sec) Em.	Abs.	Resid.
136......	RU Hya	1405*28*	292	+30	M6e	334	9.1	− 11	(+ 2)	+ 5
137......	R Cen	1409*59*	281	+ 1	M4e	(559)	6.0	− 27	− 20	− 24
138......	U UMi	141567	76	+48	M6e	328	8.3	− 39	− 26	− 13
139......	S Boo	141954	62	+58	M4e	271	8.5	− 25	(− 17)	− 3
140......	RS Vir	142205	321	+57	M6e	352	8.0	− 40	(− 26)	− 15
141......	V Boo	142539	34	+65	M6e	259	7.5	− 42	− 38	− 23
142......	R Cam	142584	87	+33	Se	271	8.3	− 44	(− 33)	− 22
143......	R Boo	143227	5	+65	M4e	223	7.1	− 60	− 58	− 44
144......	V Lib	1434*17*	305	+37	M5e	256	9.0	+ 7	(+ 15)	+ 22
145......	RR Boo	144339	33	+62	M3e	194	8.7	− 53	(− 44)	− 29
146......	U Boo	144918	349	+59	M4e	186	10.2	+ 10	(+ 19)	+ 33
147......	RT Lib	1500*18*	311	+33	M4e	252	9.0	+ 33	(+ 41)	+ 50
148......	T Lib	1505*19*	310	+31	M4e	237	9.9	− 57	(− 48)	− 39
149......	Y Lib	1506*05*	322	+41	M5e	274	8.3	− 15	(− 7)	+ 5
150......	S Lib	1515*20*	312	+29	M2e	193	8.5	+285	(+294)	+303
151......	S Ser	151714	348	+52	M5e	367	8.5	− 2	(+ 12)	+ 27
152......	RW Lib	1517*23*	310	+26	Se	203	*8.6*	+128	(+140)	+148
153......	S CrB	151731	16	+56	M7e	361	7.0	− 22	− 1	+ 15
154......	RS Lib	1518*22*	311	+27	M7e	218	7.6	− 15	(− 5)	+ 4
155......	RU Lib	1527*14*	319	+31	M(5)e	317	8.2	− 60	(− 47)	− 36
156......	X Lib	1530*20*	315	+26	M(3)e	165	10.8	− 39	(− 31)	− 22
157......	S UMi	153378	81	+36	M7e	324	8.3	− 53	(− 40)	− 27
158	U Lib	1536*20*	316	+25	M(3)e	226	9.3	+ 85	(+ 95)	+105
159	T Nor	1536*54*	294	− 1	M4e	243	7.0	− 39	− 31	− 31
160	X CrB	154536	25	+50	M6e	240	9.0	−113	(−104)	− 86
161	R Ser	154615	354	+45	M7e	357	6.9	+ 7	+ 24	+ 40
162	R Lib	1547*15*	322	+27	M(5)e	242	10.0	+ 5	(+ 14)	+ 25
163	RR Lib	1550*18*	321	+25	M4e	277	8.9	− 41	(− 33)	− 22
164	Z CrB	155229	14	+48	M4e	250	10.0	− 89	(− 81)	− 63
165	RZ Sco	1558*23*	318	+19	M4e	160	8.8	−182	(−174)	−164
166	Z Sco	1600*21*	320	+21	M6e	355	9.1	− 66	(− 52)	− 42
167	R Her	160118	0	+43	M6e	322	8.9	− 42	(− 30)	− 13
168......	U Ser	160210	350	+39	M3e	238	8.3	− 40	(− 31)	− 14
169......	RU Her	160625	9	+44	M7e	483	7.9	− 40	(− 25)	− 7
170......	S Sco	1611*22*	321	+18	M(3)e	177	9.9	+ 77	(+ 85)	+ 96
171......	R Sco	1611*22*	321	+18	M(3)e	223	10.1	− 11	(0)	+ 11
172......	W CrB	161138	27	+45	M4e	238	8.3	+ 10	(+ 20)	+ 38
173......	W Oph	1616*07*	334	+27	M(6)e	331	9.4	− 55	(− 42)	− 28
174......	U Her	162119	3	+39	M7e	406	7.6	− 44	− 28	− 10
175......	T Oph	1628*15*	329	+19	M(6)e	365	9.7	− 61	(− 47)	− 34
176......	SS Her	162807	350	+32	M3e	107	8.9	− 47	(− 46)	− 29
177......	S Oph	1628*16*	328	+19	M5e	233	8.8	− 19	(− 9)	+ 4
178......	W Her	163137	27	+41	M3e	280	8.2	− 59	(− 51)	− 32
179......	R Dra	163266	65	+38	M7e	245	7.6	−143	(−133)	−117
180......	UV Her	164012	357	+32	M6e	343	8.8	− 14	(0)	+ 18

TABLE 3—*Continued*

No.	Star	Desig.	*l*	*b*	Spec.	Period (Days)	Mag. at Max.	Velocity (km/sec) Em.	Abs.	Resid.
181......	RR Oph	1643*19*	328	+16	M(4)e	294	8.5	+ 50	(+ 60)	+ 72
182......	S Her	164715	1	+32	M5e	307	7.5	− 21	(− 10)	+ 8
183......	RS Sco	1648*44*	309	− 2	M6e	320	6.6	− 6	+ 7	+ 12
184......	RR Sco	1650*30*	320	+ 6	M6e	279	6.0	− 45	− 37	− 26
185......	SS Oph	1652*02*	344	+22	M(4)e	180	9.0	− 43	(− 34)	− 18
186......	RV Her	165631	20	+35	M2e	205	10.3	− 50	(− 40)	− 21
187......	RT Sco	1656*36*	316	+ 2	M(6)e	448	7.9	− 67	(− 53)	− 45
188......	WZ Dra	165752	46	+37	M6e	415	*10.5*	− 61	(− 46)	− 28
189......	R Oph	1702*15*	334	+13	M5e	302	7.6	− 58	(− 47)	− 33
190......	RT Her	170627	16	+32	M(5)e	298	9.8	− 76	(− 66)	− 46
191......	Z Oph	171401	351	+20	M2e	349	8.1	− 92	(− 78)	− 61
192......	RS Her	171723	13	+28	M5e	219	7.9	− 51	(− 41)	− 22
193......	RU Oph	172809	0	+20	M3e	202	9.1	− 74	(− 65)	− 47
194......	RT Oph	175111	5	+16	M7e	427	9.4	− 54	(− 40)	− 21
195......	RY Her	175519	13	+19	M4e	221	8.8	− 50	− 39	− 19
196......	V Dra	175654	50	+29	M4e	278	9.8	+ 5	(+ 13)	+ 31
197......	T Her	180531	25	+21	M3e	165	7.8	−130	−122	−102
198......	W Dra	180565	63	+29	M3e	260	9.6	− 29	(− 21)	− 5
199......	TV Her	181031	26	+20	M4e	304	9.0	− 77	(− 66)	− 46
200......	W Lyr	181136	31	+22	M4e	196	7.7	−183	−174	−154
201......	RY Oph	181103	0	+ 8	M5e	151	8.2	− 72	(− 65)	− 57
202......	RV Sgr	1821*33*	328	−12	M5e	318	7.8	+ 12	(+ 24)	+ 33
203......	SV Her	182224	21	+15	M5e	239	9.5	− 32	(− 23)	− 3
204......	T Ser	182306	4	+ 6	M7e	342	9.3	− 10	(+ 4)	+ 22
205......	SV Dra	183149	45	+22	M6e	258	9.7	+ 15	(+ 22)	+ 41
206......	RZ Her	183225	23	+13	M5e	328	9.6	+ 24	(+ 38)	+ 58
207......	X Oph	183308	7	+ 5	M6e	335	6.8	− 84	− 71	− 52
208......	AE Her	183922	20	+11	M(5)e	246	9.3	− 60	(− 52)	− 32
209......	RS Dra	184074	72	+27	M(5)e	280	8.3	− 37	(− 29)	− 15
210......	RY Lyr	184134	31	+15	M6e	327	9.6	− 32	(− 19)	+ 1
211......	ST Sgr	1855*12*	350	− 9	Se	395	9.4	+ 28	(+ 46)	+ 60
212......	Z Lyr	185634	33	+13	M5e	288	9.9	− 4	(+ 5)	+ 24
213......	RT Lyr	185737	36	+13	M(5)e	251	10.1	−102	(− 94)	− 75
214......	R Aql	190108	10	− 1	M7e	300	6.0	+ 21	+ 34	+ 52
215......	V Lyr	190529	29	+ 8	M7e	374	9.7	− 36	(− 22)	− 3
216......	RX Sgr	1908*18*	346	−15	M5e	334	9.4	− 37	(− 23)	− 10
217......	RU Lyr	190941	40	+13	M8e	370	10.6	− 14	(0)	+ 19
218......	RS Lyr	190933	33	+ 9	M(5)e	301	10.2	− 28	(− 18)	+ 1
219......	U Dra	190967	65	+23	M6e	315	9.5	− 12	(0)	+ 16
220......	W Aql	1910*07*	357	−10	Se	489	8.4	− 38	(− 18)	− 3
221......	T Sgr	1910*17*	348	−15	Se	392	8.0	− 16	(+ 2)	+ 15
222......	R Sgr	1910*19*	346	−16	M5e	269	7.3	− 52	(− 45)	− 33
223......	Z Sgr	1913*21*	345	−17	M5e	450	8.5	− 35	(− 21)	− 9
224......	S Sgr	1913*19*	347	−16	M4e	231	10.0	+ 25	(+ 35)	+ 47
225......	W Sge	191517	19	+ 1	M4e	279	*10.0*	− 74	(− 66)	− 47

TABLE 3—*Continued*

		Desig.	*l*	*b*	Spec.	Period (Days)	Mag. at Max.	Velocity (km/sec)		
								Em.	Abs.	Resid.
	RT Aql	193311	16	− 6	M7e	326	8.0	− 54	(− 41)	− 23
	R Cyg	193449	50	+13	Se	425	7.4	− 46	(− 25)	− 7
	[illegible] Aql	193509	15	− 8	M3e	219	9.1	− 84	(− 74)	− 57
	[illegible] Pav	193972	290	−31	M(4)e	244	8.0	+ 63	+ 68	+ 63
	RT Cyg	194048	49	+11	M2e	190	7.3	−126	−116	− 98
	[illegible] Cyg	194348	50	+11	M4e	219	9.5	− 90	(− 80)	− 62
	[illegible] Aql	194604	12	−13	M6e	348	8.8	+ 10	(+ 24)	+ 40
	[illegible] Cyg	194632	36	+ 2	Mpe	407	5.1	− 16	0	+ 18
	[illegible] Pav	194659	305	−32	M7e	387	7.4	− 26	− 22	− 23
	RR Sgr	194929	339	−27	M5e	335	6.6	+ 71	(+ 85)	+ 94
	RU Sgr	195142	326	−31	M4e	241	7.0	− 76	(− 68)	− 63
	RR Aql	195202	7	−17	M6e	394	8.9	+ 1	(+ 11)	+ 26
	RS Aql	195308	1	−20	M7e	413	9.9	− 14	(0)	+ 14
	Z Cyg	195849	52	+10	M5e	262	8.8	−173	(−166)	−149
	SY Aql	200212	21	−12	M5e	356	9.5	− 83	(− 68)	− 51
	S Cyg	200357	59	+13	Se	323	10.0	− 31	(− 17)	0
	S Aql	200715	24	−11	M3e	146	9.2	−120	(−113)	− 96
	RU Aql	200812	22	−13	M5e	274	9.3	+ 12	(+ 20)	+ 36
	W Cap	200822	349	−29	M(5)e	208	10.0	+ 5	(+ 15)	+ 25
	Z Aql	200906	5	−23	M3e	129	9.1	− 10	(− 6)	+ 7
246......	R Del	201008	19	−15	M5e	285	8.4	− 55	(− 46)	− 30
247......	RT Sgr	201139	329	−34	M6e	306	7.2	+ 24	(+ 35)	+ 40
248......	SX Cyg	201130	38	− 3	M7e	412	8.8	− 22	(− 8)	+ 10
249......	Z Del	202817	29	−14	Se	304	9.0	+ 22	(+ 34)	+ 50
250......	ST Cyg	202954	59	+ 8	M6e	334	9.8	− 27	(− 14)	+ 2
251......	R Mic	203429	343	−37	M4e	139	9.2	+ 4	(+ 10)	+ 17
252......	RU Vul	203422	34	−12	M3e	157	8.8	− 93	(− 86)	− 70
253......	S Del	203816	30	−16	M6e	277	9.0	− 21	(− 13)	+ 3
254......	T Del	204016	30	−17	M4e	332	9.4	− 20	(− 10)	+ 6
255......	W Aqr	204104	11	−29	M7e	380	8.4	− 29	(− 15)	− 2
256......	V Aqr	204102	17	−25	M6e	244	8.3	− 53	(− 44)	− 30
257......	V Del	204318	32	−16	M6e	536	9.9	− 39	(− 24)	− 9
258......	T Aqr	204405	10	−30	M3e	202	7.6	− 53	− 39	− 27
259......	X Del	205017	32	−18	M4e	280	8.9	− 63	− 56	− 41
260......	UX Cyg	205030	42	−10	M(6)e	562	7.4	− 20	(− 6)	+ 10
261......	RR Cap	205627	347	−41	M5e	278	8.3	− 71	(− 63)	− 56
262......	R Vul	205923	39	−15	M4e	137	8.0	− 17	(− 12)	+ 3
263......	V Cap	210124	351	−41	M5e	275	9.0	− 44	(− 36)	− 29
264......	X Cep	210382	84	+24	M5e	534	9.5	+ 7	(+ 21)	+ 33
265......	Z Cap	210516	1	−39	M3e	181	9.3	− 72	(− 64)	− 55
266......	T Cep	210868	72	+14	M7e	388	6.1	− 26	− 11	+ 3
267......	R Equ	210812	31	−25	M3e	261	9.1	− 62	(− 54)	− 40
268......	RR Aqr	210903	16	−34	M2e	182	9.2	−191	(−182)	−171
269......	X Peg	211614	34	−25	M4e	201	9.3	− 66	(− 56)	− 43
270......	T Cap	211615	4	−41	M(3)e	269	9.6	+ 35	(+ 42)	+ 50

TABLE 3—*Continued*

No.	Star	Desig.	*l*	*b*	Spec.	Period (Days)	Mag. at Max	Em.		
271	S Mic	212030	344	−47	M3e	212	9.2	+ 39	(+	
272	W Cyg	213244	59	− 5	M4e	131	5.4	− 26	−	
273	RR Peg	214024	46	−22	M5e	264	9.1	− 37		
274	V Peg	215605	34	−38	M5e	303	8.6	− 35	(− 2	
275	RT Peg	215934	56	−17	M4e	215	9.7	−120	(−	
276	T Peg	220412	41	−35	M6e	374	8.6	− 24	(-	
277	Y Peg	220613	43	−34	M3e	207	10.0	− 95	(-	
278	RS Peg	220714	44	−34	M6e	413	9.0	− 42	(	
279	X Aqr	221321	3	−56	M4e	311	8.3	− 1	(+	
280	RT Aqr	221722	1	−57	M6e	242	8.7	− 43	(−	
281	T Gru	221938	332	−59	M0e	137	8.6	− 4	(+	
282	S Gru	221948	312	−56	M5e	401	7.6	− 21	(−	
283	RV Peg	222129	58	−23	M6e	387	9.5	− 46	(−	
284	S Lac	222439	64	−15	M5e	241	8.2	− 66	− 6	
285	SS Peg	222924	56	−29	M7e	401	8.2	− 31	(− 1	
286	R Lac	223841	67	−15	M5e	300	8.3	+ 8	(+ 18	
287	S Aqr	225120	10	−64	M4e	279	8.2	− 66	(− 58)	
288	TV And	225342	70	−16	M4e	114	8.8	− 60	(− 58)	
289	RW Peg	225914	57	−41	M3e	209	9.6	− 86	(− 76)	
290	R Peg	230110	55	−45	M7e	378	7.9	+ 6	(+ 20)	+
291	V Cas	230759	78	− 1	M6e	229	7.8	− 48	− 30	− 20
292	W Peg	231425	67	−33	M7e	343	8.1	− 35	(− 21)	− 14
293	S Peg	231508	58	−48	M6e	319	8.0	− 7	(+ 5)	+ 10
294	R Aqr	233815	37	−71	M7e+Pec	387	6.4	− 30	− 17	− 18
295	Z Cas	233956	82	− 5	M7e	495	9.4	− 46	(− 32)	− 23
296	Z Aqr	234716	41	−73	M2e	138	7.3	+ 63	(+ 68)	+ 66
297	RR Cas	235053	83	− 8	M5e	300	10.4	− 56	(− 46)	− 38
298	R Phe	235150	289	−66	M3e	267	7.5	− 5	(+ 3)	− 4
299	V Cet	235209	57	−68	M3e	260	9.1	+ 43	(+ 51)	+ 50
300	R Cas	235350	83	−10	M7e	430	7.1	+ 10	+ 26	+ 34
301	S Phe	235357	282	−60	M5e	157	7.4	+ 5	+ 10	+ 2
302	Z Peg	235525	77	−36	M7e	324	8.4	− 44	(− 31)	− 26
303	W Cet	235715	50	−74	Mpe	352	7.4	− 2	(+ 13)	+ 11
304	Y Cas	235855	84	− 6	M7e	415	9.7	− 26	(− 12)	− 4
305	SV And	235939	82	−22	M7e	316	8.6	− 99	(− 87)	− 81

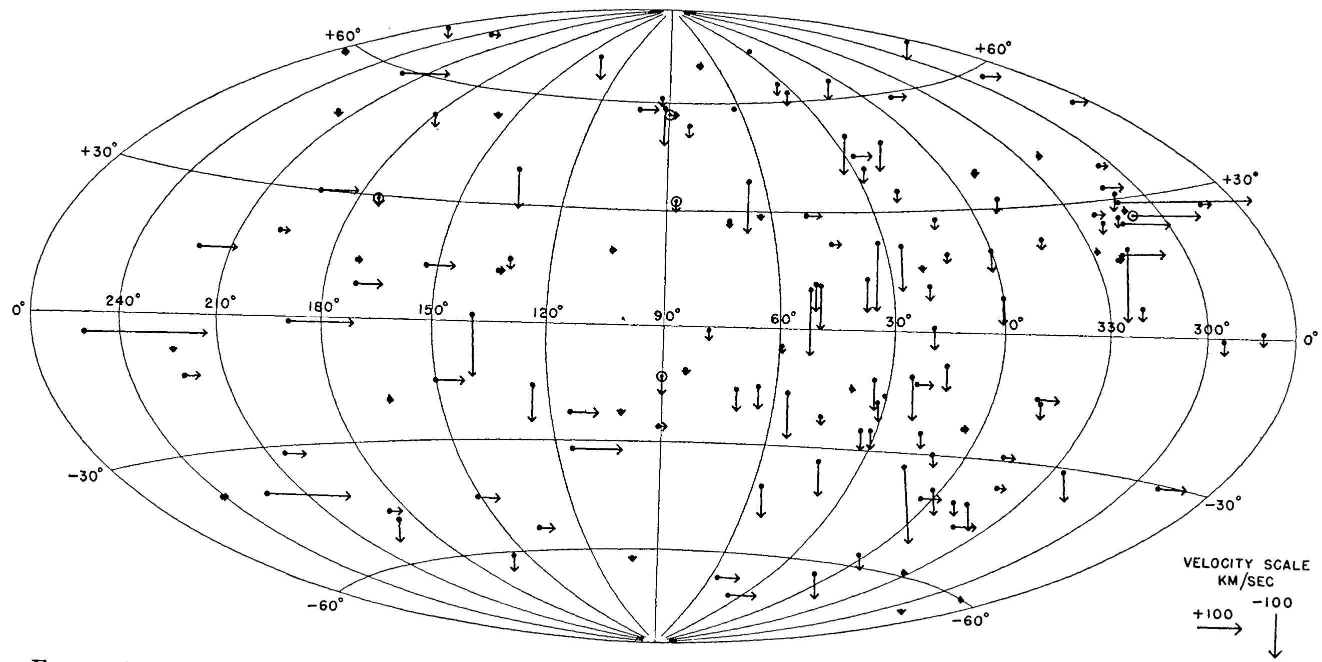

FIG. 1.—Residual radial velocities of long-period variables whose periods are equal to or less than 280 days. The positions are plotted in galactic co-ordinates; the velocities are indicated by the lengths of the arrows. Stars marked by circles are of spectral class Se; all others are of class Me.

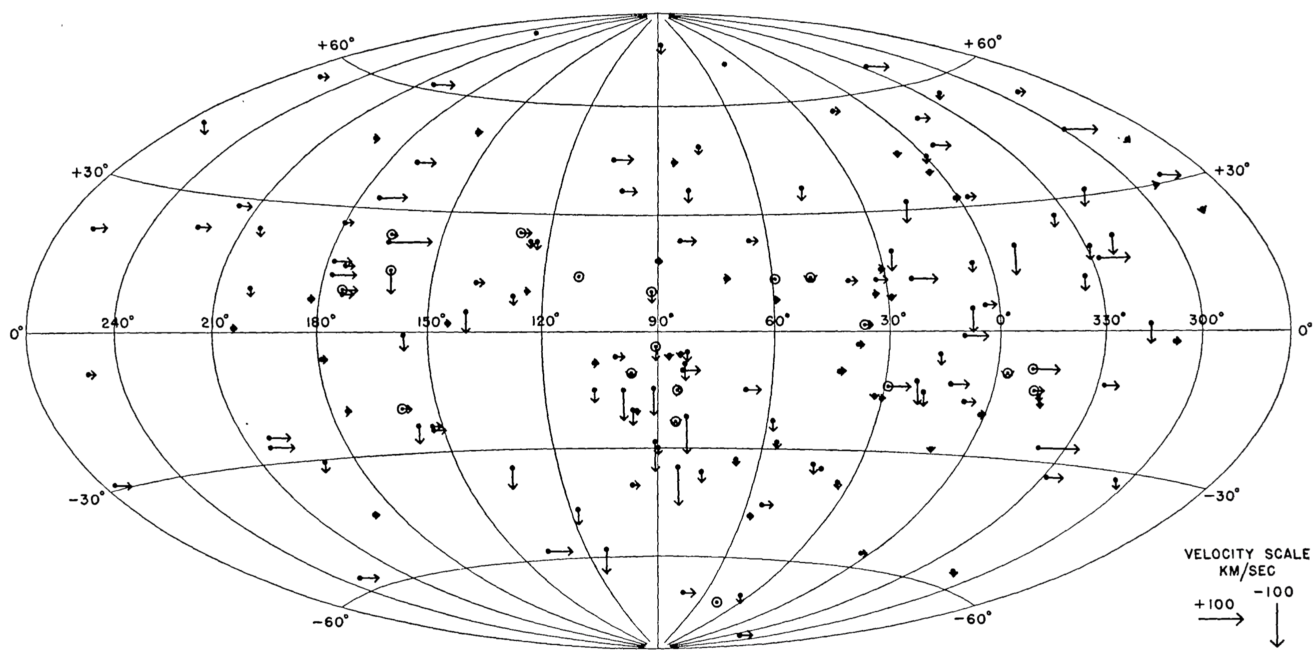

FIG. 2.—Residual radial velocities of long-period variables whose periods are greater than 280 days. Similar to Fig. 1

Spectral type and period.—The distribution in spectral type and in period of the variables listed in Table 3 is shown by Table 4. Types M3e–M7e are well represented, the greatest number of variables, 63, being in type M5e. Most of the periods fall between 200 and 400 days, with the maximum frequency in the interval 300–349 days.

Galactic concentration.—The M-type variables in Table 3, except those with very long periods, have surprisingly little concentration toward the galactic plane. The Se variables, on the other hand, exhibit a definite but not extreme concentration. The average latitudes of various groups[4] are in Table 5. The galactic distribution of the observed stars is shown in Figures 1 and 2.

TABLE 4

DISTRIBUTION OF SPECTRAL TYPES AND PERIODS OF VARIABLES WITH OBSERVED VELOCITIES

Type	No.	Period	No.
K5e	1	<100 days	1
M0e	2	100–149	15
M1e	1	150–199	27
M2e	11	200–249	48
M3e	43	250–299	61
M4e	56	300–349	75
M5e	63	350–399	43
M6e	50	400–449	24
M7e	45	450–499	6
M8e	9	>499	5
Se	24		
All	305	All	305

TABLE 5

AVERAGE GALACTIC LATITUDES OF STARS IN TABLE 3

Type	No.	Average Latitude	Period	No.	Average Latitude
K5e–M4e	114	32°.5	<300 days	152	32°.1
M5e–M8e	167	28.1	300–400	118	28.1
Se	24	20.0	>400	35	20.9

DISCUSSION OF MOTIONS

The earlier paper[1] brought out several interesting facts concerning the motions of long-period variables. The average residual radial velocity proved to be remarkably high—about 36 km/sec. Especially surprising was the fact that very high velocities are not evenly distributed with respect to spectral type and period but are largely confined to stars of types M2e–M5e and to those having periods in the neighborhood of 200 days. A well-marked group motion, corresponding to the "velocity asymmetry" exhibited by other high-speed stars, was disclosed.

[4] Because of obscuration the number of the more distant variables observed in low latitudes is unduly small. Toward the center of the galaxy the effect becomes noticeable at a distance of about 800 parsecs. Thus the average latitudes in Table 5 are slightly larger than those corresponding to the actual space distributions of the variables, but the appropriate corrections would not be large.

The greatly increased number of stars with measured velocities (305 against 133 in the earlier discussion) now provides a broader basis for statistical studies. We can thus be more confident that the results properly represent the general behavior of Me and Se variables.

The velocity measured directly from the spectrograms is, of course, the relative velocity of star and observer. That part of the velocity supplied by the rotation and the orbital motion of the earth is at once removed by applying the "reduction to sun," leaving as a result the relative velocity of star and sun. This datum (next-to-last column of Table 3) is that usually published; but, since this velocity has as origin a single body of negligible cosmic importance, it seems logical to make a second correction, namely, that necessary to transfer the velocities from the sun to the centroid (practically the center of gravity) of a group of hundreds of stars relatively near the sun. This has been done, and the corrected motions, called "residual velocities" (last column of Table 3), are used in all the computations which follow.

The galactic distribution of the stars and certain general features of the radial velocities may be seen from Figures 1 and 2. The asymmetry of the velocity distribution is shown clearly by Figure 1, in which are plotted the variables with periods equal to or less than 280 days. Notice the preponderance of motions of approach between longitudes 0° and 90°, that of motions of recession near 220°. In Figure 2, which includes variables with periods greater than 280 days, the velocities are smaller and the asymmetry less marked.

An interesting group of variables lies near longitude 315°, latitude +25° ($\alpha = 15^h 30^m$; $\delta = -21°$); of 6 with high velocities (5 in Fig. 1, 1 in Fig. 2), 5 are receding, 1 approaching.[5]

Stars close together in the sky may have widely different velocities. A striking pair is formed by R and S Scorpii, 1611*22*, only about 3′ apart, with velocities of 0 and +85 km/sec, respectively. On the other hand, certain pairs not so close have nearly the same velocity. Examples are R and S Columbae, 0546*29* and 0543*31*; S and U Lyncis, 063558 and 063159; S and T Delphini, 203816 and 204016.

Residual velocities.—The residual radial velocities are decidedly high, the arithmetic mean for the 305 stars being 36.1 km/sec,[6] the algebraic mean, −0.9 km/sec. A plot of the residual velocities against spectral type (Fig. 3) shows that the extremely high velocities tend to occur in the earlier types rather than in the later ones and that the relative number of small velocities increases steadily with type. Detailed data are in Table 6.

The remarkable fact, previously detected,[1] that high velocity is associated with short period is confirmed by the new data. A good idea of the relationship may be gained from Figure 4. All residual velocities greater than 100 km/sec correspond to stars with periods less than 275 days. Mean velocity decreases with increasing period except for a small group of stars with periods less than 150 days. The correlation appears somewhat better marked than that with spectral type. An interesting example is furnished by the one outstandingly high velocity in class Se (see Fig. 3). This velocity belongs to RW Librae, 1517*23*, a variable with a period of 203 days—exceptionally short for class Se—and thus, when plotted against period, falls in with a group of high-velocity Me stars (Fig. 4). Detailed data concerning velocity and period are in Table 7.

[5] By a curious coincidence two near-by nonvariable stars—HD 134439 and HD 134440—have velocities of about +300 km/sec, nearly equal to that of S Librae, 1515*20*; while another, HD 140283, has a velocity of −170 km/sec, about equal to that of RZ Scorpii, 1558*23*. These HD objects are dwarf stars relatively near the sun, two of them with large tangential motions; hence the close agreements with the variables in radial velocity are probably fortuitous.

[6] The corresponding value from 133 stars was 35.5 km/sec (*Mt. W. Contr.*, No. 264; *Ap. J.*, **58**, 215, 1923).

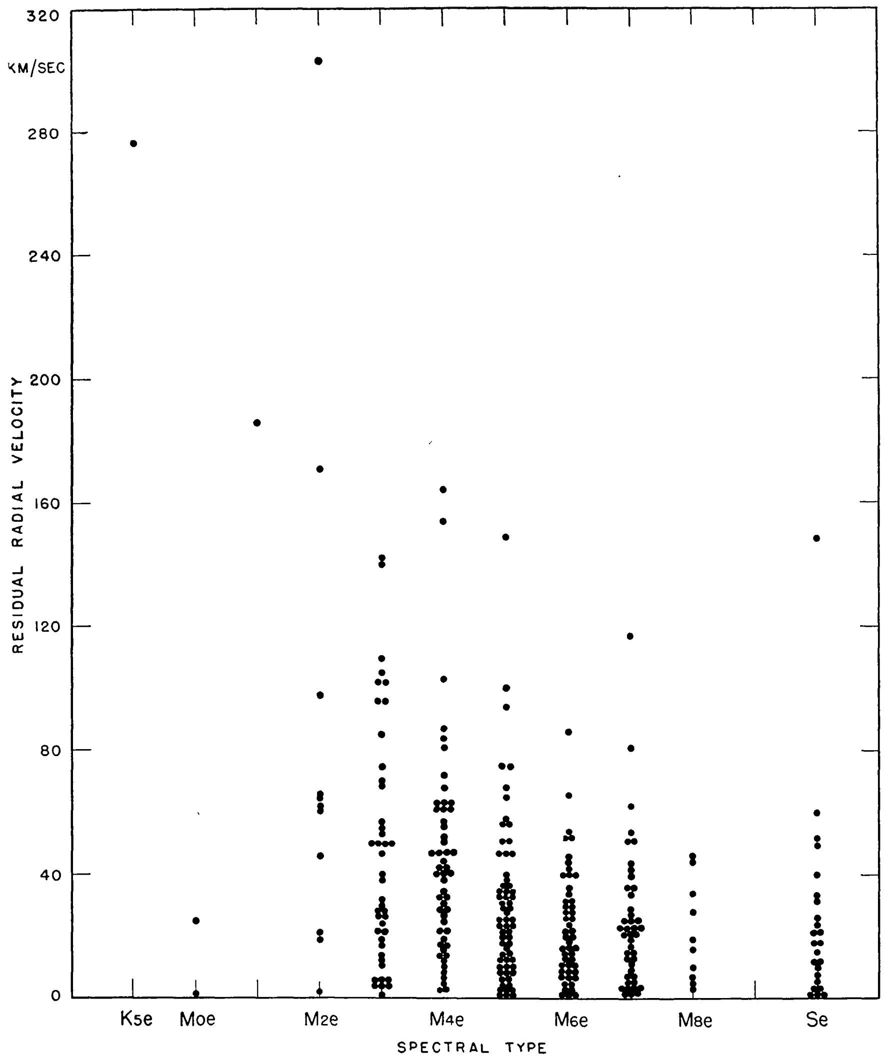

FIG. 3.—Residual radial velocity and spectral type

TABLE 6

RESIDUAL VELOCITY AND SPECTRAL TYPE

Type	No.	Mean Velocity	Numbers of Stars with Velocities within the Limits Indicated					
			0–20 km/sec	20–40 km/sec	40–60 km/sec	60–80 km/sec	80–100 km/sec	>100 km/sec
		km/sec						
K5e–M2e....	15	94	3	2	1	4	1	4
M3e........	43	49	12	9	9	3	4	6
M4e........	56	43	14	13	16	7	3	3
M5e........	63	31	23	25	8	4	2	1
M6e........	50	25	22	17	9	1	1	....
M7e–M8e...	54	25	25	18	8	1	1	1
Se..........	24	26	13	6	3	1	....	1
All......	305	36	112	90	54	21	12	16

Group motion.—Residual velocities obtained by correcting the measured radial velocities for the solar motion of 20 km/sec toward $\alpha = 270°$, $\delta = +30°$, have been used in the following computations concerning group motion. Hence it must be borne in mind

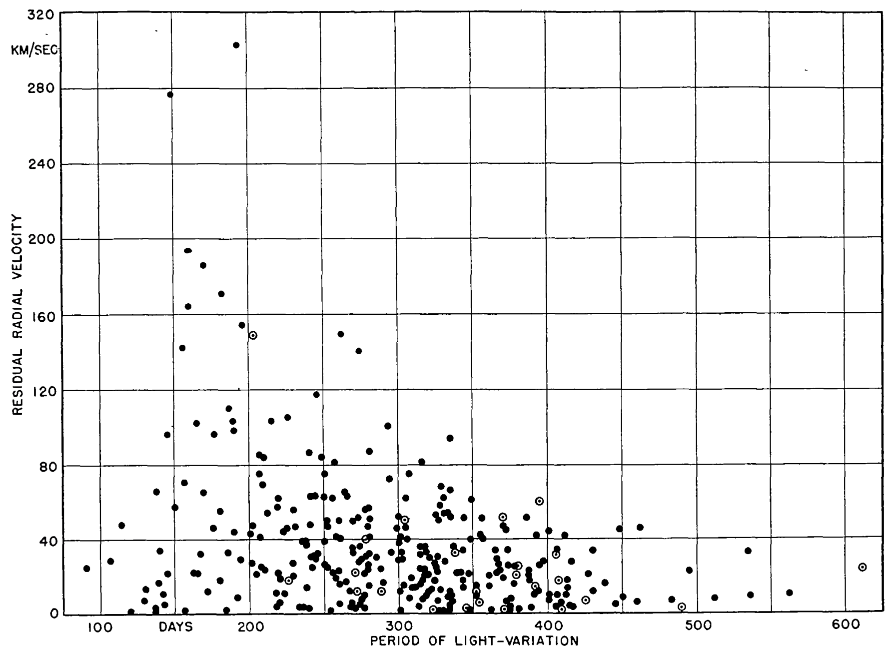

FIG. 4.—Residual radial velocity and period of light-variation. Stars marked by circles are of spectral class Se; all others are of class Me.

TABLE 7

RESIDUAL VELOCITY AND PERIOD

Period	No.	Mean Period	Mean Velocity	Numbers of Stars with Velocities within the Limits Indicated					
				0–20 km/sec	20–40 km/sec	40–60 km/sec	60–80 km/sec	80–100 km/sec	>100 km/sec
days		days	km/sec						
<150	16	132	41	8	4	1	1	1	1
150–199	27	176	80	5	5	4	2	2	9
200–249	48	225	45	10	15	10	5	4	4
250–299	61	271	38	17	19	14	6	3	2
300–349	75	323	29	30	24	13	6	2	....
350–399	43	374	23	19	15	8	1	....	....
>399	35	445	17	23	8	4	....	....	....
All	305	294	36	112	90	54	21	12	16

that all the values derived for the velocity and for the position of the apex refer not to the sun itself but to the centroid of the solar group of stars. Use of this system of coordinates simplifies the interpretation of galactic motions.

Rectangular components of the group motion of the variables were computed by the method of least squares, the observational equations having the form

$$x \cos \alpha \cos \delta + y \sin \alpha \cos \delta + z \sin \delta + K = v\,. \quad (1)$$

The results for various groupings of stars are in Table 8, which gives, instead of the rectangular components, the speed, V_0, of the centroid, and the apex in equatorial co-ordinates, A_0, D_0, as well as in galactic co-ordinates, L_0, B_0.

TABLE 8

SOLUTIONS FOR GROUP MOTION

Group	No.	Average Residual Velocity: From Standard Solar Motion	Average Residual Velocity: From Solution	K	V_0	A_0	D_0	L_0	B_0
		km/sec	km/sec	km/sec	km/sec				
I All....................	305	36.2	.....	+ 8.0	36.5	311°.3	+51°.9	58°	+ 5°
			34.9	0	30.8	315.8	+50.3	59	+ 2
II Residual vel. <25 km/sec............	142	11.8	.....	+ 0.1	4.1	270.7	+30.2	24	+21
			11.6	0	4.0	270.8	+29.2	23	+21
III Residual vel. ≥25 km/sec............	163	57.5	.....	+13.1	67.9	316.0	+53.6	61	+ 4
			46.7	0	59.8	319.7	+54.6	63	+ 3
IV Period >300 days.....	150	24.4	.....	+ 6.6	15.9	329.2	+51.4	66	− 3
			24.1	0	11.3	325.1	+42.8	65	−12
V Period ≤300 days......	155	47.7	.....	+ 9.4	58.0	310.8	+51.0	57	+ 5
			42.7	0	51.9	316.6	+51.4	60	+ 2
VI Modulus ≤9.2 mag....	151	34.5	.....	+ 8.9	37.3	282.7	+46.0	43	+18
			33.8	0	33.0	281.7	+46.4	43	+19
VII Modulus >9.2 mag....	154	38.0	.....	+ 6.4	38.9	339.3	+46.1	69	−11
			36.1	0	33.9	345.3	+40.1	70	−18

In group I all 305 stars were included. For additional solutions the stars were divided into two approximately equal groups according to (*a*) residual velocity, II and III; (*b*) period of light-variation, IV and V; and (*c*) distance from the sun, VI and VII. For each group two solutions were carried out, one using equation (1) and another in which K was assumed to be zero.

The positive values of K may indicate that the velocity of recession near the antapex is larger than that of approach near the apex; or it may be caused in part by a preponderance of stars with positive velocities in the zone midway between the apex and the antapex. For example, the group of stars, including S Librae, lying near $\alpha = 15^h 30^m$, $\delta = -21^\circ$, whose mean velocity is positive, must contribute to a positive K. A systematic error of measurement may, of course, be involved, but the very small value of K yielded by the stars with residual velocities less than 25 km/sec makes it probable that this error is not large. The largest value of K is found in group III, which includes the stars with the highest residual velocities. It is a curious circumstance that in every group the omission of K leads to a smaller value of V_0. This indicates in another way the rather fortuitous nature of the positive K term. For general studies of the galactic motions of stars which are not uniformly distributed over the whole sky, solutions with K put equal to zero may be preferred.

Results for groups I, III, and V are somewhat alike. Groups III and V include stars with high velocities, III by direct selection, V through the correlation of high velocity with short period. In group I (305 stars), because of the method of least squares, the large residual velocities tend to control the solution and make the results resemble those of III and V. The interesting features of these solutions are the large values of V_0 and the fact that the apex lies near to that point in the sky, $l = 56°$, $b = 0°$, toward which the solar group of stars is moving in its circular galactic orbit.[7]

The solution for group II, based on small residual velocities, stands by itself. Not only is the K term practically zero, but V_0 is only 4 km/sec. The close agreement of the apex with the ordinary apex of solar motion is surprising. The interpretation is that with respect to the centroid the low-speed variables have a group motion of 4 km/sec in a direction almost exactly opposite to that of the motion of the sun. Evidently the velocity asymmetry does not extend to these slowly moving stars; as a general hypothesis suggests (see p. 214), it is doubtless more directly correlated with high space motion than with variability or spectral type. Group IV yields a rather small value of V_0, but the apex falls in a different position.

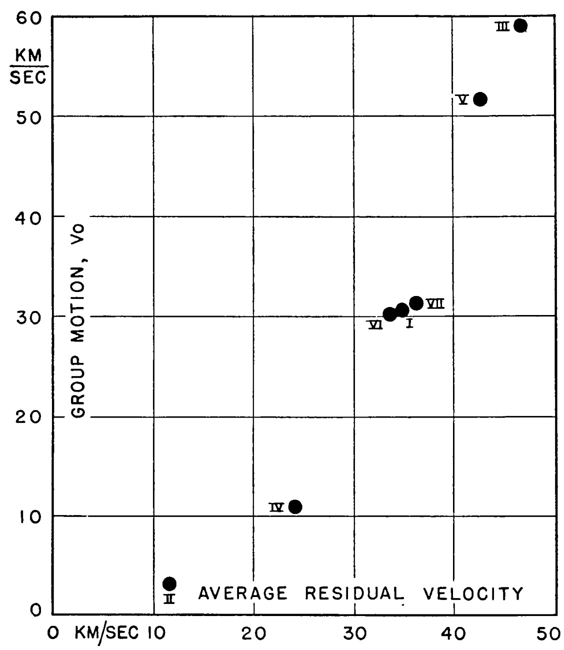

FIG. 5.—Group motion, V_0, plotted against average residual radial velocity.

A remarkable kinematic property of the variables is presented by the increase in V_0 from 4.0 km/sec for the low-speed stars (group II) to 59.8 km/sec for the high-speed stars (group III). The values show how rapidly the velocity asymmetry becomes effective as the random speed increases. A similar increase, although less marked, is found in the values of V_0 for groups IV and V. On the other hand, there is practically no difference in the values of V_0 for groups VI and VII, in which the basis of selection is distance. This fact emphasizes the dependence of V_0 upon residual velocity.

The relationship between group motion and random velocity is shown in Figure 5, in which the average residual velocities from the various solutions (Table 8) are plotted against the values of V_0 projected on the line toward the apex of galactic rotation, $l = 56°$, $b = 0°$. The points fall near a curve similar to the parabola previously found by Gustaf Strömberg[8] from a more general study of stellar motions.

It is well known that stars with rapid space motions do not in general move wholly at random but are subject to a certain "velocity asymmetry," that is to say, to a general group motion in a certain direction. This direction is approximately opposite that in which stars in the neighborhood of the sun are moving in their huge orbits about the

[7] It should be borne in mind that the values of V_0 in Table 8 refer not to the sun but to the centroid.

[8] *Mt. W. Contr.*, No. 293; *Ap. J.*, **61**, 363, 1925.

center of the galaxy. The apparent group motion may thus be largely the reflection of the galactic rotation upon a group of stars which for some reason have abnormally low speeds of rotation. In other words, the so-called "high-speed" stars are those for which the circular component of the galactic orbits is less than the average for stars in the same vicinity. The radial component, i.e., the motion toward or away from the galactic center, may at the same time exceed the average.[9]

Long-period variables are among the stars exhibiting the velocity asymmetry. Indeed, they constitute an especially interesting example because of the fact that well-marked kinematic properties are found in a group selected on the basis of physical characteristics. The results of solutions III and V appear to furnish a striking confirmation of the general interpretation of the behavior of high-speed stars.

Since the more distant variables, group VII, do not appear to have much faster motions than the nearer ones, group VI, it is surprising to find a considerable difference in the positions of the calculated apices. To what extent this result represents an actual spatial relationship is hard to say. The lack of faint variables in the southern sky may have some effect. It is noteworthy, however, that the apex for the fainter, more distant variables, group VII, lies to the east of the apex for the nearer ones, group VI—a result similar to that found previously for other stars.[10] Several problems arising from the computations summarized in Table 8 should be considered in relation to the larger problems of stellar motions in general.

High stellar velocities exhibit certain kinematic relationships which seem more or less independent of the physical characteristics of the stars involved. This fact has a reasonable interpretation in the hypothesis of galactic rotation already mentioned.

Much harder to understand is the well-marked correlation between high velocity and the physical properties of the stars. The solution of this mystery would take us far deeper into the fundamental facts of stellar evolution than we have yet been able to penetrate. Some general suggestions of interest in this connection have been made by Strömberg.[9] The attack upon the evolutionary problem from the standpoint of galactic behavior and that based on the generation of energy in stellar interiors should eventually converge.

A further discussion of the motions of long-period variables to include the available data on proper motions is planned by Dr. R. E. Wilson and the writer.

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[9] A brief summary of the development of these ideas is given by Strömberg, *Mt. W. Contr.*, No. 492; *Ap. J.*, **79**, 460, 1934.

[10] F. K. Edmonson, *A.J.*, **42**, 157, 1933; Ralph E. Wilson and Harry Raymond, *A.J.*, **47**, 49, 1938.